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SOILS OF THREE EXPERIMENTAL WATERSHEDS IN ALBERTA AND THEIR HYDROLOGIC SIGNIFICANCE

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled:

SOILS OF THREE EXPERIMENTAL WATERSHEDS IN ALBERTA AND THEIR HYDROLOGIC SIGNIFICANCE,

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ABSTRACT

The management of wildlands for water catchment purposes requires a realistic understanding of the importance of soils in the hydrologic cycle. This necessitates the collection of data on soil in terms of hydrologic parameters, which are then classified by way of a soil's ability to store and transmit water.

This study was undertaken to describe, classify, and map wildland soils, to determine their hydrologic characteristics, and to interpret this information for watershed management purposes.

Three experimental watershed basins in the uplands of southwestern Alberta were selected for this investigation. Detailed soil surveys as well as physical, mineralogical, chemical, and micropedological analyses were conducted in order to meet the needs of this study.

Detailed survey indicated that numerous soil types were present in these watershed basins. The large number of soil types made it impossible to delineate regions in which specific soil series occurred. General regions were delineated on the basis of Great Soil Group dominance. Well-drained soils in Marmot Creek Basin reflected a vertical zonation with Gray Luvisols (Gray Wooded soils) at the lower elevations and passing through Ferro-Humic Podzols and Dystric Brunisols to Regosols at the higher elevations. The characteristics of the soils from the alpine tundra region in this basin supported the contention that the timberline in the Rocky Mountains reflects a climatic tension zone. Black and Dark Gray Chernozemic soils were the dominant well-drained soils in Streeter Creek Basin, with Gray Luvisols, Eutric Brunisols, and Regosols occupying lesser areas. Deer Creek Basin had a uniform

soil distribution pattern consisting of Gray Luvisolic soils.

A large proportion of the soils encountered met only in part or not at all the requirements for classification into the Canadian System of Soil Classification. Poorly-drained as well as imperfectly-drained soils in Marmot and Streeter Creek Basins, which are normally classified in the Gleysolic Order or the Gleysol Subgroups, did not exhibit the required gleying and/or mottling. The drainage of such soils was assigned on the basis of vegetative association, geomorphology, and/or topographic position. In addition, many of the well-drained soils in these watershed basins had properties which were not defined at the higher levels of abstraction of the Canadian System of Soil Classification. Such soils were classified into the respective Great Soil Groups or Orders which accommodated or reflected their dominant morphological and/or analytical characteristics. These observations prompted the recommendation that the Canadian System of Soil Classification be revised or amended to accommodate soils from mountainous areas.

Preparation of the soil maps was accomplished according to conventional cartographic procedures and by a computer mapping technique. Computer mapping was found to be of time-saving significance.

Analyses indicated that most soils in Marmot and Streeter Creek Basins had a higher capacity to transmit water than the maximum storm - rainfall intensity on record. Interpretation of the soil survey information and analytical results indicated that the soils in the three basins are generally fairly to moderately suitable for water catchment. Estimated improvement of water yield resulting from conversion of forest to grass vegetation, suggested an insignificant response.

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I. INTRODUCTION

The management of wildland areas is normally designated as multiple use and includes such management aspects as forestry, recreation, range, wildlife, and watershed. Theoretically, these management aspects require equal consideration in any one region. In practice, these aspects are normally scaled according to economic or social importance. The East Slopes region of the Rocky Mountains in south-western Alberta is an example of such a stratification. Catchment of water is considered of much greater value than any other management aspect, since the greater part of the water available for the Canadian Prairies is derived from this region.

A lack of information presently exists with respect to the role that soils play in the maintenance of stream run-off in Canadian watersheds. In studies conducted elsewhere, determination of the different kinds and the hydrologic properties of soil were found to be an essential step in watershed management investigations. Such investigations are normally conducted on small watershed basins which are selected as representative of a given region. The watershed management area in south-western Alberta has three such experimental basins.

The purpose of this project is to determine whether or not a careful study of the soils in these experimental basins provides data which may assist in establishing suitable management practices for ensuring optimum yield and quality of water. To achieve this purpose it is felt that the following objectives should be pursued:

(1) to examine in detail and map the soils in the experimental watershed basins;

(2) to conduct chemical and physical studies in the field and laboratory in order to characterize the mapping units and establish their hydrologic significance;

(3) to evaluate the soils in terms of utilization for watershed management;

(4) to evaluate the present taxonomic and mapping units, as set up by the Canadian Soil Classification Committee, for detailed watershed mapping.

II. LITERATURE REVIEW

Soil Forming Factors Effective in Mountain Regions

Mountainous landscapes usually support numerous soil types as a result of rapid environmental changes within relatively short distances. The soil pattern may be expected to be complex, depending on the combination of soil-forming factors active in any specific location.

In most instances mountainous regions are characterized by very steep topography. This has two pedogenically important consequences, related to the type of bedrock material. In the case of hard rock, lateral leaching is of greater significance than vertical leaching. When dealing with soft rock, erosion causes a constant rejuvenation of the soils. Rejuvenation of soils on slopes has a significant influence on plant regeneration (Amen, 1966) and results in fine material enrichment on local terraces. Mountain slopes are, therefore, often characterized by soils ranging from weakly developed to well developed. The well developed soils, the characteristics of which more fully express the environmental conditions, are usually located on the more gentle slopes (Duchaufour, 1965). This effect of relief on soil formation was clearly demonstrated by Smith (1956) in his study of Spitzbergen soils. Soil distribution was expressed as a catenary association in which denudation played a very prominent role. As a consequence, variability among the more important soil characteristics was related to the degree of slope. The pH value and pH range of the soils decreased, drainage became poorer, and textures became finer with decrease in slope.

The usually rugged topography of mountainous regions results in a climate which is locally dependent on aspect and altitude. In the temperate latitude of the northern hemisphere, north-facing slopes have a cooler micro-climate (Shreve, 1924), more humus (Sartz and Huttinger, 1950) and initially slower humus decomposition (Duchaufour, 1965; Retzer, 1948) than south-facing slopes. Soils are characteristically more acid on north-facing than on south-facing slopes, although the reverse may occur at lower elevations as a result of dessication (Duchaufour, 1965).

An increase in altitude is generally accompanied by a decrease in temperature and an increase in precipitation. Alteration of organic material and eluviation are greatly reduced above the tree-line, so that the soil profile usually has a well-developed organic horizon but thin and poorly differentiated mineral horizons (Duchaufour, 1965). As a consequence, the characteristics of mountain soils are more uniform on an areal basis at the higher elevations. Alteration of organic material is more intense with a decrease in elevation. Other factors being favourable, podzolization may occur and the development of eluvial and illuvial horizons may be observed.

The climatic effect of altitude is subject to local or regional modifications. The correlation between altitude and temperature may be modified by topography. Broad, flat mountain valleys having poor air drainage are often affected by temperature inversions on wind-still nights (Baker, 1944). Elevation and precipitation correlations are greatly modified in mountainous areas by such factors as approach effects, rain shadows, and canyon effects (Baker, 1944). To these variations must also be added the characteristics of different

climatic seasons, including regionally prominent phenomena such as chinook winds and degree of snow sublimation. The formation of structured soils in the vicinity of the nival range is the immediate result of soil disturbance by periodic occurrences of soil frost (Troll, 1958).

Much of the influence of climate on soil formation is the result of the control it exercises over vegetation. A prominent feature in areas of steep topography is the stratification of vegetation into horizontal zones. These zones reflect changes in climate; the upper limit of each vegetation zone being determined by temperature (Griggs, 1946; Larsen, 1930). The growth and character of the vegetation may further be influenced by wind (Holch, et al., 1941; Warren Wilson, 1959), mist (Kerfoot, 1968), and other climatic conditions (Holch, et al., 1941; Johnson and Billings, 1962). Timberlines in the Rocky Mountains and in the Appalachians are true tension zones determined by climate; in both cases, wind direction and intensity being responsible (Griggs, 1946). In such tension zones the dominance of climate over vegetation results in the formation of soils with more development than normally associated with such vegetation. Bliss and Woodwell (1965) have described a pseudo-alpine Podzol under sedge-heath vegetation near the summit of Mount Katahdin, Maine. Franz (1956) has described pseudo-alpine Rankers (Duchaufour, 1965, classification) under forest vegetation in Europe.

In general, the kinds of plants native to any region play a vital role in the types of soil which eventually evolves. The influence of vegetation on soil development is reflected by the organic matter content of the surface soil (Retzer, 1948). Within a given

vegetal-climatic zone, the microbial population and consequently the character of the organic matter tends to remain similar (Brandsberg, 1967; Hintikka and Näykki, 1967; Taylor, 1928). This is of great importance, since soil development is closely linked with the action of diverse organic substances upon the parent material (Konanova, 1966). Least developed soils are found under the alpine turf, which is characterized by shallow rooting (Holch, et al., 1941) and produces an organic residue that mineralizes rapidly but that does not cause vast alteration of the parent material (Duchaufour, 1965). Forest vegetations favour the formation of an incipient B horizon, chiefly because of the very deep rooting and of the nature of the humus. Lower-elevation grass-lands are characterized by deep A horizons, rich in organic matter, formed by deep rooting (Holch, et al., 1941) and a high degree of humification of the organic residue (Duchaufour, 1965).

Mountainous regions are characterized by extreme variations in parent material. Rocks of igneous, metamorphic, and sedimentary origin may all be present as well as recent alluvial, colluvial, aeolian, and till deposits. The parent material effect on soil formation in mountainous regions usually appears to be of lesser importance than topography, climate, and vegetation. Only when conditions are favourable can one observe a difference between acidic and calcareous parent rock on soil evolution (Duchaufour, 1965). As a consequence, soil analogs are the rule rather than the exception when comparing areas of different parent materials. Such profile analogies are more complete and quicker attained at higher altitudes, because of the increased effect of climate on pedogenesis (Duchaufour, 1965).

Parent material variations do exert a strong influence on soil

characteristics within any given bioclimatic zone. Soil characteristics reflecting parent material influences include soil textures, soil fertility, and erodibility. Soils developed on coarse-textured biotite granites in the Ponderosa pine (Pinus ponderosa) zone are usually shallow, infertile, acid and erodible while those developed on basalt in the same zone are usually deep, fertile and stable (Retzer, 1948). Limestones tend to produce calcareous soils in the grassland and savanna zones and also in the alpine zone (Bamberg and Major, 1968; Duchaufour, 1965; Ehrlich, Rice and Ellis, 1955). Soils from ferruginous limestone may have reddish colours, while soils from rhyolite, in the same zone, may give white, leached-appearing profiles. Shales produce clay textures and sandstones produce sandy loams. Soils with high gravel and stone content are very common and tend to favour moisture infiltration and transmission. Glacial till deposits are highly valuable for water catchment because of their rocky, porous nature (Retzer, 1948).

Soil Patterns in Mountainous Areas

Rapid change in the magnitude of the soil forming factors within short distances makes it difficult to divide mountainous areas into regions in which specific soil series or soil patterns of specific series occur. It may be possible, however, to deliniate general regions in such areas in which certain Great Soil Groups predominate. Distribution patterns of Great Soil Groups may be predicted relative to vertical zonation, type of vegetation, parent material, or aspect. Such broad-distribution patterns would be, of necessity, only of regional significance.

Duchaufour (1965) equated zonal soils with parent material and vertical zonation in Western Europe. In the Lower Montane zone, Acid Brown, Ochre Podzolic, and Podzol soils are associated with siliceous parent material versus Rendzina with calcareous parent material. Podzolic and Ranker soils are zonal soils developed from siliceous parent material whereas Podzolic and Rendzina soils are associated with calcareous parent material in the Subalpine and Upper Montane zone. Alpine humus soils are the zonal soils for the Alpine region, regardless of parent material.

Jeffrey et al. (1968) investigated the relationship between soil, topography, elevation, and parent material in the Upper Oldman River Basin, Alberta, Canada. Steeper slopes were found in areas of calcareous parent material than in areas of non-calcareous parent material. The zonal soils on calcareous parent material were Gray Wooded at the lower basin elevations; Brown Wooded near the mid-slope elevations; and Mull Regosol at the higher elevations. On non-calcareous parent material, Podzol soils were found at the lower elevations, Acid Brown Wooded soils at mid-slope elevations, and Mull Regosols at the higher elevations.

Johnson and Cline (1965) studied the relationship between soils, elevations, and ecosystems in Colorado. In the Lower Montane climax region, between the 6,000 and 8,000 foot contours, the major soils were Chestnut, Degraded Chernozem, Brown Forest and Gray Wooded. The Upper Montane region, which extends from 8,000 feet to 9,300 feet M.S.L., has as major soils: Grey Wooded, Bog Soil, Brown Forest, Brunizem, Chestnut and Chernozem. In the Subalpine climax regions, between 9,300 feet and 11,400 feet M.S.L., the major soils included

Brown Podsolic, Podsol, Groundwater Podsol, Brown Forest, Grey Wooded, and Bog Soil. The Alpine Tundra region, which extends up to 14,400 feet M.S.L., has as major soils: Alpine Meadow, Alpine Turf, Bog Soil, and Lithosols.

Soil-plant relationships and vertical zonation were studied by Spilsbury and Tisdale (1944) in the southern Interior of British Columbia. The Lower Grassland vegetation zone had Brown Chernozems, the Middle Grassland zone had Dark Brown Chernozems, and the Upper Grassland zone had Black Chernozems as major soils. Podzol soils were found in the three forested zones which were located above the grassland zones. The authors recognized three types of Podzol soils, which at that time could not be differentiated any further. It appears that these Podzol soils presently would be classified as Grey Wooded, Podzol, and Degraded Acid Brown Wooded. These soils were associated with the Montane Forest, the Subalpine Forest, and the Upper Subalpine Forest zone, respectively.

Relationships between soils and vegetation within the Upper Columbia Valley were investigated by McLean and Holland (1958). Precipitation appeared to be the principal factor governing both soil formation and vegetative growth. Zonal soils in the valley bottoms were Dark Brown Chernozem formed under grass. With increase in elevation and precipitation, zonal soils progressed to Brown Wooded, Grey Wooded, and eventually to Podzol. These soils were associated with the Douglas Fir, the Cedar-Hemlock, and the Spruce-Fir zone, respectively.

Crossley (1951) conducted investigations on the Kananaskis Forest Experiment Station soils in south-western Alberta. He found

that the zonal soils of the forested area were Chernozem, Rendzina, Brown Wooded, Grey Wooded, and Podzol.

It is evident that mountainous regions can be delineated by predominance of certain Great Soil Groups. Correlations between Great Soil Group and parent material, topography, precipitation, elevation and vertical zonation facilitate the prediction of Great Soil Group distribution patterns. The considerable variation in the nature of these correlations emphasizes that such distribution patterns are only of regional significance.

The Significance of Soils in Watershed Management

A watershed is a social and economic unit encompassing community development, conservation of water and soil, and protection and use of timber and forage. As a consequence, watershed management has as its objectives to control erosion and pollution, to reduce sediments in streams, to exert maximum control of floods, and to increase the yield of usable water. The premises on which watershed management is based are twofold (Rowe and Colman, 1957); namely

1. plant cover, soil, and rock mantle function as a reservoir to receive, store, and discharge water;
2. the behaviour of this reservoir and the stability of the soil are subject to change under land use.

Soil as a reservoir to receive, store, and discharge water. According to Hursh and Fletcher (1942), the soil profile behaves as a natural reservoir having the following types of reservoir functions:

1. permanent retention storage; resulting in a complete loss of water to run-off.

2. groundwater detention storage; resulting in an equalizing effect upon stream flow during non-storm periods (equivalent to water in non-capillary pores).

3. stormwater detention storage. This storage is represented by the moving gravitational water that reaches the stream in sufficient time to contribute to the storm hydrograph. It may or may not proceed to the normal watertable before being transmitted to the stream.

Underground water storage in many soils is subject, however, to definite physical limitations (Hursh, 1943), particularly inherent to shallow or eroded soil profiles. Because of limited soil depth, a shallow soil may have 4 to 8 acre inches less total storage opportunity than a deeper counterpart. Eroded soil profiles may have less than one-third the macro-pore storage in the first 36 inches than is found in comparable non-eroded soils.

Morse (1946) observed some correlation between stream flow behaviour and soil profile characteristics. In the four watersheds selected, each of which was uniform with respect to the nature of soil, he observed that a "lithosol" watershed had a large flow for at least one percent of the time and was dry part of the year. A "gravelly" watershed did not have a large flow for one percent of the time and did not dry up during the season. A "planosol" and a "half-bog" watershed were intermediate to the lithosol and the gravelly watersheds, since they had a large flow for at least one percent of the time but they did not dry up during part of the year.

The stability of the soil and, indirectly, the reservoir

function is greatly affected by vegetation. Different plant communities vary in the extent of their stabilizing ability. Turner and Dortignac (1954) found that on sites with different grass cover-types, Thurber fescue was the most efficient ground protection in reducing total erosion while needle grass was the least efficient. They also observed that the high volume of surface run-off in bluegrass may cause gullying and channel cutting on lower lying downstream land. Kittredge (1954) found that for the same soil type, a dense stand of pine allowed an average run-off of only 0.61 inches/year, while an undisturbed grass cover allowed a total seasonal run-off of 3.79 inches. The computed erosion for the same run-off, however, was found to be twice as great from pine as from grassland.

Plants have a profound bearing on soil structure and porosity; not only because of their rooting habit, but also because of litter production. Plant debris, in particular forest litter, as a soil cover has been the subject of extensive investigation. Forest litter or the L-H horizon is very important from the watershed management point of view, as is evident from the following summarized properties (Kittredge, 1948; Trimble and Lull, 1956; Youngberg, 1963):

1. It has a very high water holding capacity as compared to the inorganic soil.

2. It retards the date on which the underlying mineral soil begins to freeze.

3. It reduces the depth to which the soil freezes.

4. It tends to keep frozen soil porous, loose, and permeable during periods in which bare soil becomes solid and imperme-

able.

5. It inhibits thawing of a soil.

6. It reduces evaporation.

7. It increases aggregation of the soil.

8. It protects the soil from rain impact and hence

   a) prevents erosion and decreases surface run-off;

   b) increases infiltration.

<u>The effect of land use on the reservoir function and on soil stability.</u> In most instances, the water problem of a given region is primarily a forest problem. Land use effects on the reservoir function and soil stability are, therefore, chiefly related to such practices as logging, recreation, grazing, and to the incidence of fires. The advance of civilization may also create water problems as a result of cultivation of steep or marginal lands (Munns, 1947) and as a result of exploration practices (Wyldman, 1967).

Removal of forest vegetation generally results in a reduction of transpiration and in an increase in water available for run-off (Jeffrey, 1964). So long as the soil and its organic cover are not disturbed, this does not alter the reservoir function or soil stability. However, commercial logging for example, causes soil disturbance in the form of soil compaction and the removal of the organic soil horizon on the skid trails. Grazing and recreation also result in soil compaction and litter removal. Fires have the same effect as cover removal by cutting. The effect of soil compaction and litter removal on the reservoir function of the soil is to decrease

the water holding capacity and the infiltration, while soil stability is affected by the consequential increase in surface run-off and associated erosion.

Munns (1947) reported on the influence of logging in the Coweeta catchment, North Carolina. Selective logging with no soil disturbance resulted in marked increase in stream flow throughout the year. At no time during the year was there a significant increase in storm run-off or a change in water quality. Commercial logging, on the other hand, resulted not only in changes in stream and storm flow but also in changes in the quality of the water.

Coltharp (1960) investigated the general effects of commercial logging on soil characteristics in Michigan. There were no pronounced indications of changes in soil texture, bulk density, porosity, or permeability as measured for the first six years after logging. There was an increase in soil organic matter but a decrease in litter content. Soil moisture increased significanctly after one year and mean soil and air temperatures also increased. The average and maximum rates of run-off dropped slightly and infiltration increased slightly after cutting. In general, there was no significant change in the established hydrological characteristics of the watershed.

The effect of fire on watershed management has been studied by Hoyt and Troxell (1934) in a southern California basin and by Anderson, Duffy, and Yamamoto (1966) in Hawaii. Rapid changes in the hydrograph and increased streamflow resulted. Although these authors did not investigate specific changes in soil characteristics, this can be inferred from other fire studies. Beaton (1959[a]; 1959[b]) observed that fire resulted in decreased total porosity and increased micro-

pore space. The infiltration rate of burned soils was also decreased as was the thickness of the litter. Most of the effects of fire upon soil chemical properties appeared to be restricted to the surface organic horizons.

Grazing on low-elevation grasslands and on forested range has usually been found to affect soil compaction as evidenced from bulk density measurements (Beke, 1961; Duvall and Linnartz, 1967; Kucera, 1958; Linnartz, Hsu and Duvall, 1966). In general, the bulk density of surface soil horizons increases and infiltration decreases, heavy grazing being more damaging than moderate grazing. Soil compaction resulting from grazing does not seem to impair forage growth or to accelerate erosion (Duvall and Linnartz, 1967), but does restrict water movement especially during intense rainstorms. Timber range tends to be more susceptible to grazing influences, because of better surface soil structure as compared to pasture or old-field soils (Broadfoot and Burke, 1958).

Bulk density studies on arid rangelands appear to be inconclusive as a measure of soil compaction (Beke, 1961; Lodge, 1954; Orr, 1960). This may be the result of variability in soil, moisture, or other conditions. Laycock and Conrad (1967) investigated the effect of grazing on soil compaction on a high elevation range in Utah. Soils in exclosures and on the adjacent range were sampled to determine the difference in compaction on grazed and ungrazed areas, as measured by bulk density, and to determine the relation between density and various soil characteristics. The sampling locations had either seeded grass or sagebrush-grass vegetation. The soils were developed on sedimentary rock of the Browns Park and Morgan formations

and had a loam to clay loam texture. These authors found no difference in bulk density between grazed and ungrazed plots in early summer before grazing and in late summer after grazing. Increases in bulk density during the summer on both areas were attributed to changes in soil moisture.

Recreational use affects the reservoir function and soil stability by compaction of soil and removal of litter. An incidental recreational effect is the higher proportion of forest fires. Dotzenko, Papamichos and Romine (1967) investigated the effect of recreational use on soil in the Rocky Mountain National Park. They found that intensive use resulted in a decrease in organic matter and moisture content of soils, accompanied by an increase in bulk density.

A comparison of land treatments to develop concepts of land management for water production was conducted by Harrold, et al. (1962), at Coshocton, Ohio. Land treatments evaluated were for several levels of crop production and for timber production. Higher levels of management increased the infiltration potential when the particular soil type was amenable to change. The infiltration was largest on small watersheds converted from idle land to farm woodlots. Increased crop production and conversion to timber production resulted in an increase in soil moisture utilization and, consequently, a decrease in percolation potential.

Hydrologic Soil Characteristics

Water flow and erosion are controlled by certain properties inherent to the soil and to the rock beneath. A first approximation of these parameters was given by Hursh and Hoover (1941). They

recognized storage opportunity and transmission rate of water as the two most essential soil profile characteristics pertinent to hydrologic studies. The most recent and presently accepted concept (Canadian National Committee for the International Hydrologic Decade, 1966) is a modification of this first approximation. The parameters recognized are:

1. Storage capacity. This determines the extent to which water flow conditions can be changed by land management practices, such as for reduction of surface flow of storm water and for reduction of evapotranspiration of soil water. Storage capacity may be subdivided into:

a) detention storage, which pertains to water that is normally drained by gravity. This water is available for evaporation when the water table is shallow, and results in interflow, seepage, ground water recharge, and ultimately streamflow.

b) retention storage, which pertains to water that is retained in the soil by tension forces. This type of water storage does not contribute significantly to streamflow, but, is depleted by evaporation and transpiration.

The storage capacity of a soil is a function of porosity, and, hence, is affected by soil depth and the texture and structure of the soil horizons. A measure of detention and of retention storage capacity is provided by specific yield and specific retention determinations, respectively. These determinations are obtained through the measurement of porosity and 1/3 atmosphere moisture tension.

2. Transmission capacity. This effects the watershed management objective for erosion control by providing such information as rate of surface run-off and rate of infiltration. The following types of flow through the soil profile must be recognized:

a) infiltration, which pertains to water entering the soil;

b) unsaturated flow, which is relatively slow flow and may occur in any direction in response to tension gradients;

c) saturated flow, which is flow occurring laterally or vertically in response to potential gradients (pressure and elevation).

The transmission capacity of a soil is a function of its texture and position in the profile. It is affected by vegetative cover, surface litter, soil structure, texture, moisture content, depth, and state (e.g. frozen). A measure of the different types of flow is provided by infiltration rate and hydraulic conductivity determinations.

Interpretive Soil Classification for Watershed Management

Measurements of the hydrologic soil characteristics are normally too time consuming and too costly to be carried out on a large scale. In order to keep such measurements to a minimum, it is essential that they be equated to land areas. In general, soil series or soil survey mapping units are used for areal representation. This facilitates extrapolation of results to surveyed areas outside the watershed research area. Research has indicated that certain morphological soil features provide an estimate of hydrologic soil properties and, therefore, need to be emphasized in future soil surveys.

Morphological soil features, that require emphasis in hydrologic soil surveys include:

1. nature and depth of the L-H horizon and ground vegetation in forested areas (Kittredge, 1948; Trimble and Lull, 1956) or the vegetation type on rangelands (Turner and Dortignac, 1954);

2. amount and shape of coarse skeleton within the soil matrix (Epstein, Grant and Struchtemeyer, 1966);

3. nature and degree of compaction of the parent material (Hanks, 1965; Holtan and Creitz, 1967);

4. depth to bedrock (Munns, 1947).

The detail of hydrologic soil surveys depends on various factors, such as time, financial support, and complexity of the area. When dealing with relatively uniform areas, reconnaissance surveys have been found satisfactory, although mapping at the series level is deemed mandatory (Leven and Williams, 1967; Rowe and Colman, 1957). Watershed areas located in climatic tension zones may require a more detailed level of survey, chiefly because of greater soil complexity.

The preparation of the interpretive or technical soil map involves the grouping of soils with similar hydrologic characteristics. Ideally this should involve all hydrologic soil parameters, but, in practice, normally one parameter is selected for this purpose. The method presently employed in the United States (Soil Conservation Service, 1964) involves the grouping of soils on the basis of minimum infiltration rates for bare soil after prolonged wetting. This criterion simultaneously provides an estimate of the permeability of the impeding stratum, provided that the least pervious horizon is not at the soil surface (Baver, 1956; Schmid, 1967). Four soil groups

are recognized in this system which are designated as A, B, C, and D. Soils in group A have the highest infiltration and permeability rates and lowest surface run-off while soils in group D have the lowest infiltration rates and highest surface run-off. The selection of minimum infiltration rates appears to be the most logical basis for hydrologic soil grouping since it would be least affected by management practices. These soil groups are subsequently used in the estimation of potential maximum retention storage for predicting water yields. The equation employed (Soil Conservation Service, 1964) gives reliable results in the case of wet soil conditions.

Major difficulty has been encountered in obtaining reliable parameters as a basis for estimating infiltration rates. Since watershed retention is estimated as a volume, Holtan (1965) has proposed the use of volumes of soil moisture capacity rather than infiltration rates for use in calculating watershed retention. Such volumes are finite and would place a ceiling on errors inherent in estimated infiltration rates. Holtan, England and Allen (1967) have presented moisture storage volumes for a number of soils in the northeastern United States. Although these results are inconclusive for purposes of hydrologic soil grouping, they do provide a finite measure of water storage.

A serious objection to Holtan's proposal is his assumption that hygroscopic moisture is not considered as part of soil water storage. The separation of potential storage into gravitational and plant-available-water may also be criticized. Hewlett and Hibbert (1963) have shown that unsaturated conditions in mountain soils contribute to base flow and may constitute the chief aquifer for stored water

between rains. The accepted lower limit of gravitational soil water, 1/3 atmosphere tension, is therefore not applicable in hilly and mountainous terrain.

Interpretation of soil survey information for watershed management has been attempted by Leven and Williams (1967) in Arizona. The object of their hydrologic survey was to outline areas with greater water-yield potentials. The hydrologic soil properties characterized were hydraulic conductivity of the least permeable horizon, plant available water, and aggregate dispersion. These properties were found to be directly related to the soil-forming parent material. Soil depth, slope, and geologic type were used as water-yield improvement criteria related to vegetation conversion.

Summary of Literature Review

The combination of soil forming factors active in mountainous regions has been shown to change rapidly within relatively short distances. As a consequence, mountainous landscapes usually support numerous soil types. Soil profile analogies become more complete and are quicker attained with increase in altitude, because of a corresponding increase in the influence of climate on soil formation.

The large numbers of soil types makes it impossible to divide mountainous areas into regions in which specific soil series occur, or in which patterns of specific series can be predicted. General regions can be delineated, however, on the basis of Great Soil Group dominance. Distribution patterns of Great Soil Groups can be predicted relative to parent material, topography, precipitation,

elevation, and vertical zonation. The results of various investigators indicate that such distribution patterns are of regional significance only.

Soils have been shown to function as a natural reservoir by their ability to store and transmit water. Watersheds, which differ in soil type and parent material, vary in their reservoir behaviour. Profile features, such as limited soil depth and soil erosion, adversely affect the storage and/or transmission capacity of soils, while deep forest litter and moderate stoniness are beneficial profile characteristics. Combined results of various investigators indicate that soils under forest have a greater infiltration capacity and soil-moisture utilization than corresponding soils under grass. However, grassland soils are less erodible than forested soils.

Some land-use practices tend to cause compaction and erosion of soil, thereby adversely affecting soil stability and the reservoir function of soil. Studies have shown that commercial logging and intense recreational use create mostly localized conditions of soil compaction and erosion, which are confined to skid trails and campgrounds, respectively. Fires and heavy grazing tend to produce similar but more general effects, although different intensities of compaction and erosion occur within a given area. Higher levels of management for forest and crop production improve the infiltration potential and increase soil-moisture consumption.

The combined results of hydrologic investigations have indicated that interpretation of soil survey information for watershed management requires consideration of all hydrologic soil parameters. Exact details of these parameters for interpretation are still in

doubt. Empirical attempts have used minimum infiltration or limiting permeability as the sole hydrologic parameter. Limiting permeability, plant available water, aggregate dispersion, soil depth, slope, and geologic type were employed as parameters in an interpretive study designed to estimate potential improvment in water yield.

In conclusion, the importance of soil interpretation for watershed management has received considerable attention in recent years. Most of this attention has been directed to studies which employ only one hydrologic soil parameter for hydrologic soil interpretations, although some progress has been made concerning multiparameter interpretations. The hydrologic soil parameters to be used for interpretation remain unsolved. Diversity of soil types in watershed management areas complicates this problem.

III. DESCRIPTION OF THE AREA

The Watershed Management Area

The Saskatchewan River headwaters (Fig. 1) constitute the Alberta wildland area in which watershed management is of principal importance. The headwaters are located in the extreme west of the Province of Alberta (Jeffrey, 1965) and extend from latitude 49^{o} 00' N to 53^{o} 02' N, signifying a length of 290 miles. Their longitudinal boundaries are the Alberta - British Columbia border and the 4,000 M.S.L. contour to the east thereof. Variations in width range from 25 to 120 miles. The total headwaters area comprises approximately 15,400 square miles.

The management area is characterized by rugged topography and is steeply sloping. Elevations vary from 4,000 feet M.S.L. to about 12,000 feet M.S.L. Two distinct physiographical regions occur within this area which are known as the Upper Foothills and the Cordilleran region. The Upper Foothills region extends from 4,000 feet M.S.L. to about 6,000 feet M.S.L. It is characterized by high, rounded hills and deep valleys with coniferous forest at the higher elevations grading through mixed wood stands to grasslands and shrub at the lower elevations. The Cordilleran region of the management area encompasses all wildlands above the 6,000 foot contour and is characterized by steep slopes and deep valleys. Vegetative cover ranges from subalpine coniferous forests at the lower elevations to alpine tundra; the tree line approximately coinciding with the 8,000 foot contour.

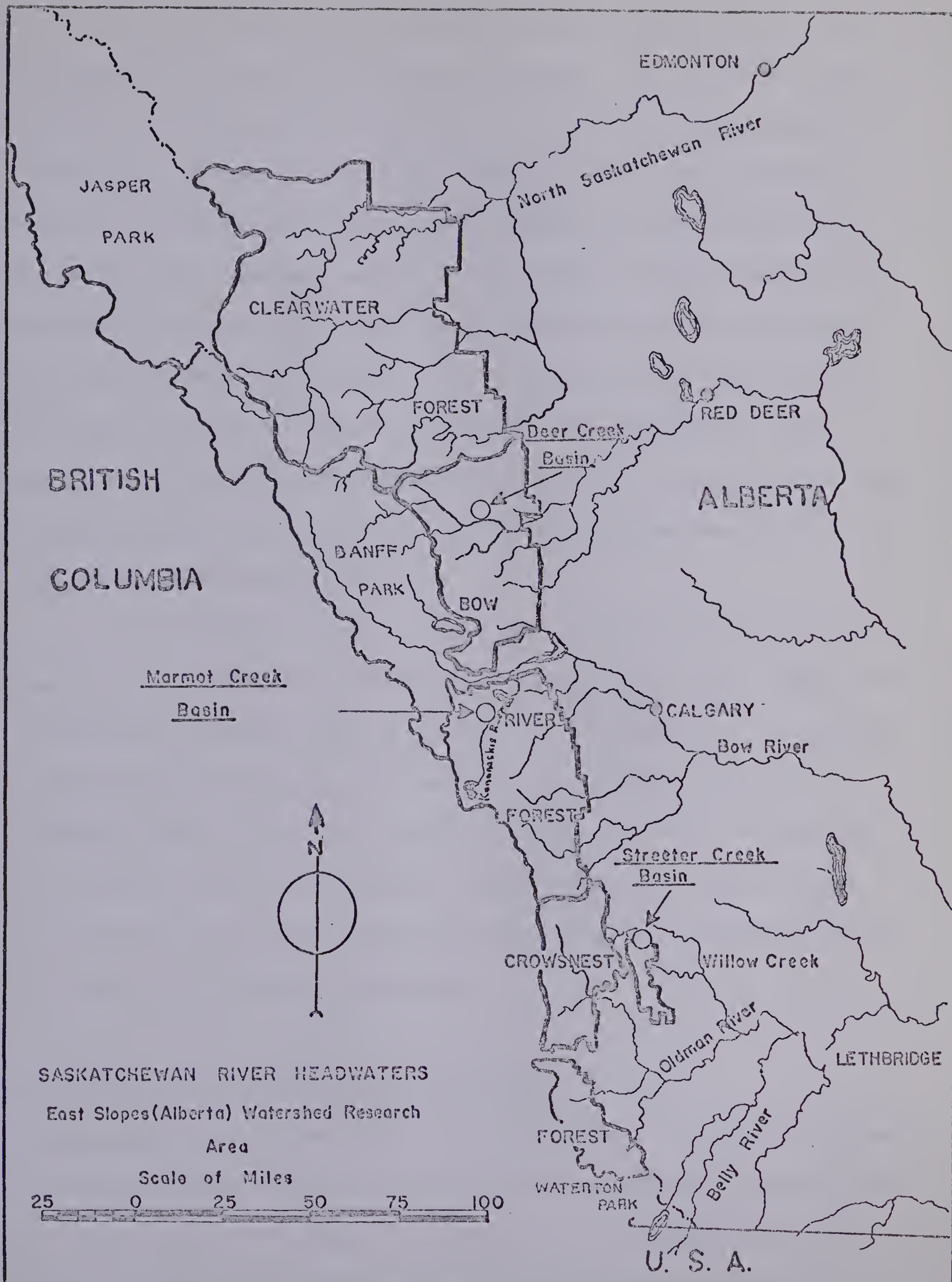


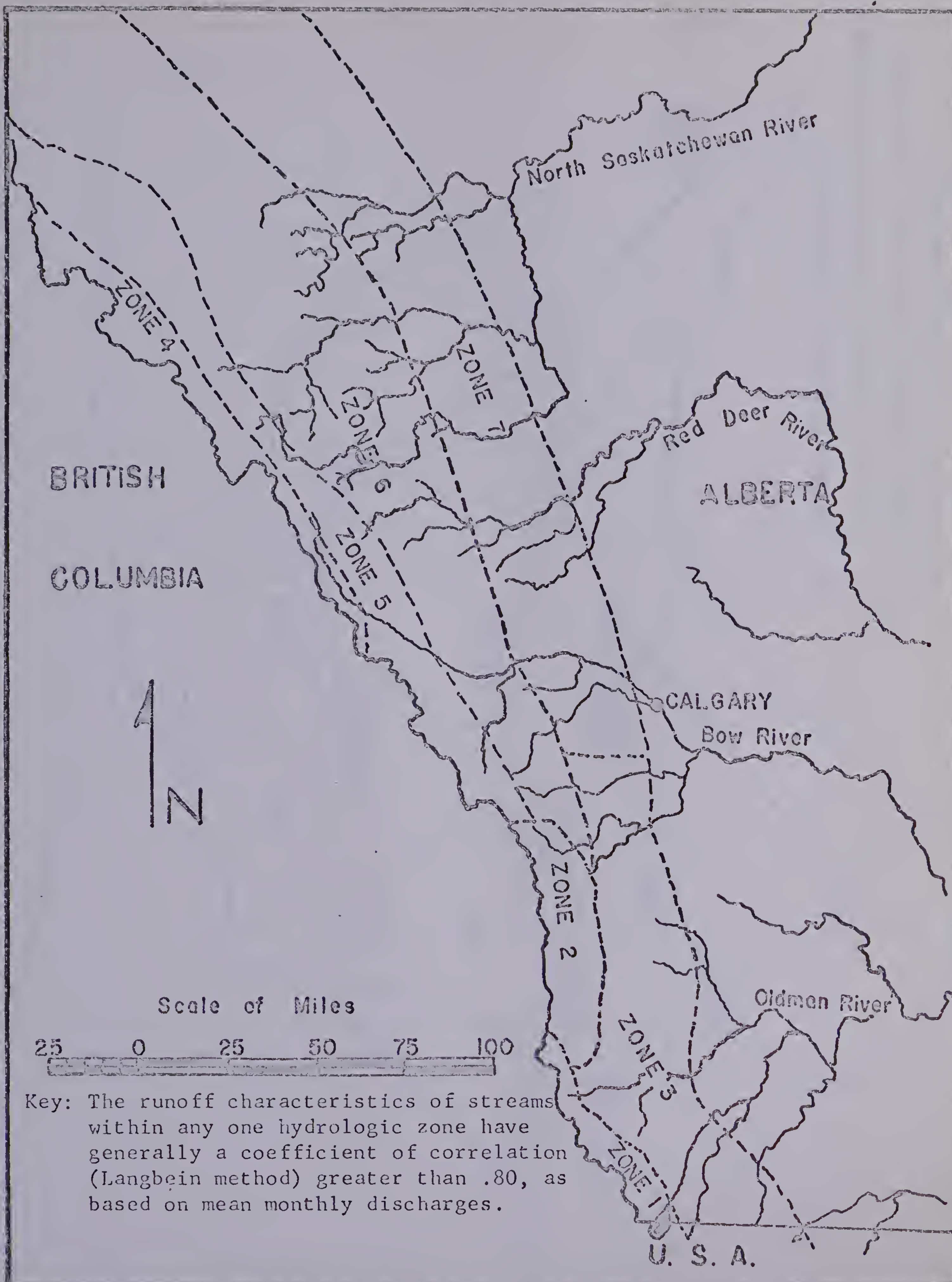
Figure 1. Saskatchewan River headwaters.

The climate in the management area is highly variable, and furthermore, information is relatively sparse. Recorded mean annual precipitation varies from 10 inches in the foothills and intermontane valleys to 45 inches at the higher elevations where precipitation is mainly in the form of winter snowfall (McKay, Curry and Mann, 1963). The winters are cold and long, with warm chinook (föhn) winds causing occasional interruptions. The average frost-free period is generally less than 60 days (Bowser, 1967). Streamflow records, which provide an estimate of the precipitation falling within a watershed, have been analyzed by Davis and Coulson (1967). Seven hydrologic zones are recognized within the management area which are considered to be basically climatic zones (Fig. 2).

The Foothills region of the area is primarily underlain by Mesozoic rock. Devonian - Carboniferous rocks in the Front Ranges and Proterozoic - Cambrian rock in the Main Ranges constitute the geology of the Cordilleran region. The area has been heavily glaciated (Heusser, 1956) so that till deposits are common. Soils of the area are chiefly Podzolic and Brunisolic under coniferous forest, except for the peats and organic soils of the bog forests. Chernozemic soils are found under grassland vegetation.

The Experimental Watershed Research Basins

Marmot Creek Basin. The basin is located in the steep-walled Kananaskis River Valley about fifty miles west of Calgary, Alberta, in Tp 23, R9, W5. Total area of the basin is approximately 3.6 square miles. The basin is divided into three sub-basins, having areas of 0.8, 1.1, and 1.0 square miles, respectively (Fig. 3). Elevations in the basin



Key: The runoff characteristics of streams within any one hydrologic zone have generally a coefficient of correlation (Langbein method) greater than .80, as based on mean monthly discharges.

Figure 2. Hydrologic zones in the Saskatchewan River headwaters.

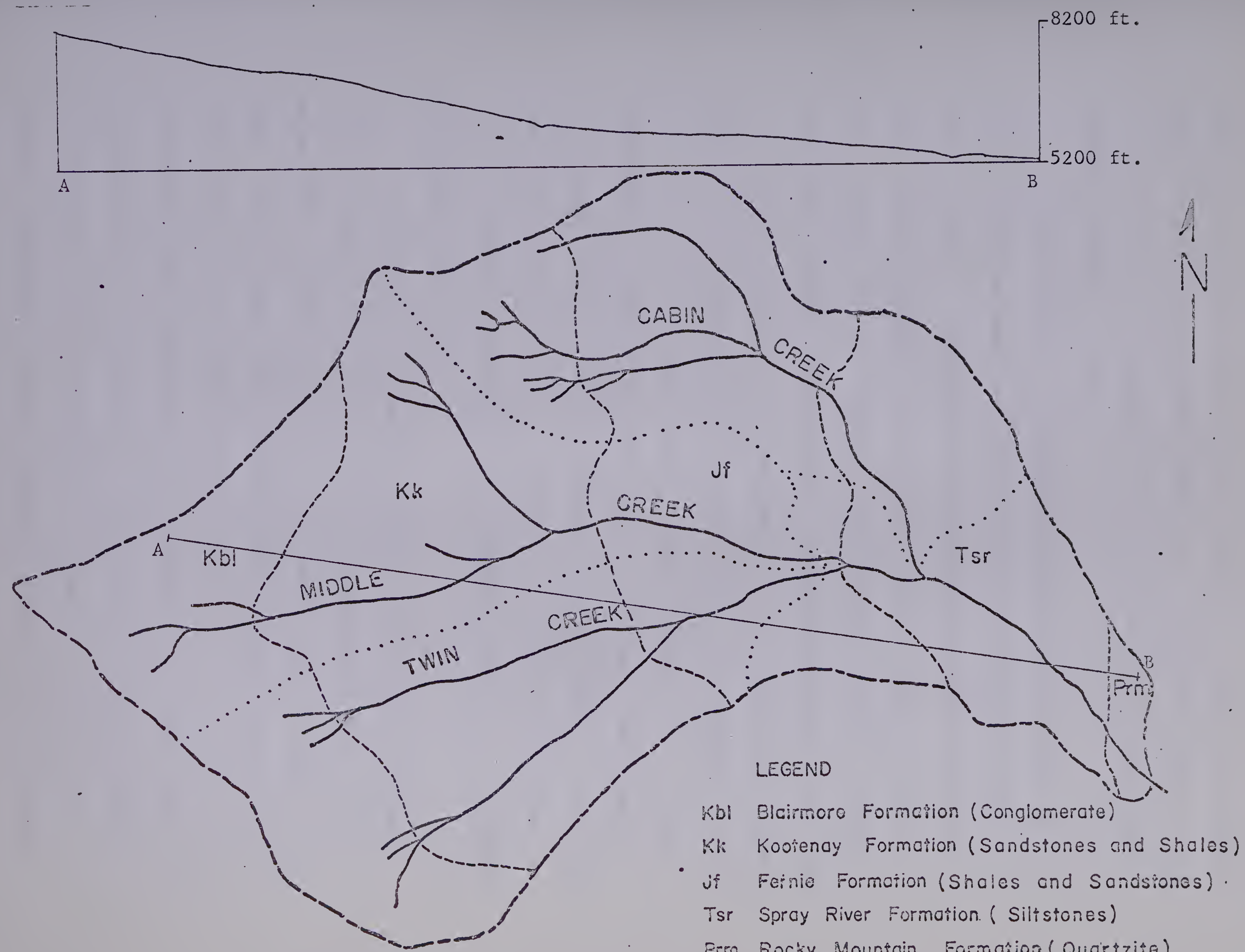


Figure 3. Bedrock geology of Marmot Creek Basin.

range from 5,200 feet M.S.L. to 9,200 feet M.S.L. Mean elevation per basin area is at approximately 6,930 feet. The general aspect of the basin is easterly. Topography is steeply sloping, averaging 39 per cent for the basin as a whole.

The collection of hydrometeorological data has been in progress since the basin was selected for study in August 1962 (W.S.C., 1966-a). Precipitation data presented by Storr (1967) show that the average summer rainfall varies from 9.8 inches at the 5,200 foot contour to about 13 inches at the 8,000 foot contour. Average total annual precipitation over this same elevation range varies from 26 to about 40 inches. As a consequence, rainfall constitutes approximately 30 per cent of the annual precipitation, the remainder being in the form of snow and sleet. Summer rainfall appears to be the more effective form of precipitation in the basin, since a large part of the snow and sleet is lost by sublimation (Harlan, 1969). Most of the summer precipitation occurs in June and early July. The maximum rainfall intensity measured for the recording period was 1.00 in./hour on September 10th, 1963.

The minimum temperature recorded in the lower basin was -32°F. in January 1963, '64, and '65; the maximum of 86°F. was in August 1965. Summer temperatures are somewhat lower at higher elevations. During August 1966, the mean monthly maximum temperature at 5,700 feet M.S.L. was 57.5°F. and at 7,100 feet M.S.L. 56.3°F. Corresponding mean monthly minima were 39.5°F. and 41.1°F., and monthly means 49.5°F. and 48.7°F., respectively. Nightly temperature inversions occur occasionally in the basin, as indicated by relative humidity and minimum temperature data for the basin and by

relative humidity measurements of the Kananaskis Valley (MacHattie, 1966) as a whole.

Soil temperatures at 72 inches depth ranged from 30 to 43°F. throughout the year, regardless of aspect and elevation. The soil-humus interface had a much larger range in temperatures which appeared to be influenced by thickness of humus and by aspect (Hillman, 1967). Under an uncut, mature spruce-fir stand, the soil-humus interface on a south-facing slope had a yearly maximum temperature in 1966 of 54°F. as compared to 44°F. on a north-facing slope at about the same elevation. Corresponding yearly minima were 28°F. and 25°F., respectively. The respective yearly means were 33.5°F. and 36.5°F. at the soil-humus interface and 35.5°F. and 34.5°F. at 72 inches depth. The maximum soil depth at which temperature fluctuations were directly noticeable was 24 inches.

Mean daily stream discharge and monthly flow at the stream gauge control in the lower basin tend to be lowest in March and highest in June (W.S.C., 1966-a). Bed load measurements, conducted in weir pools, indicate that the stream channels are well stabilized; sedimentation being very low. Suspended sediment content in water samples taken at the lower weir is very low; the highest concentration recorded was .124 grams per litre in November, 1963. Calcium and magnesium bicarbonates are the main surface water constituents. Alkali salts are very low and the heavy metals are almost absent in these waters. At the lower weir, total hardness in 1966 varied from 212 ppm. in April to 113 in early July. Measurements of pH at this location in 1966 showed variations ranging from 7.7 to 8.5.

The bedrock geology of Marmot Creek Basin as shown in

Figure 3, comprises five formational units, ranging in age from late Paleozoic to early Cretaceous (Crockford, 1949). A resistant quartzite member of the Rocky Mountain Formation, Late Paleozoic age, crosses the lower portion of the basin, and outcrops at the base of the confluence area. Marmot Creek has cut a deep gorge through this bench just outside the basin boundary. The Spray River Formation of Lower Triassic age underlies most of the confluence area and consists predominantly of thin bedded siltstones. It outcrops along Marmot Creek and along the lower reach of Cabin Creek. The Fernie Formation of Jurassic age consists primarily of dark gray to black shale which reflects on the relatively smooth slope of the terrain. A more rapid increase in slope near the midline and the upper limit of the Fernie Formation is the result of the more resistant Pigeon Creek Sandstone Member and the Upper Fernie Sandstone "Passage Beds", respectively. Overlying the Fernie Group is the Kootenay Formation of Upper Jurassic to Early Cretaceous age, which is the thickest rock unit in the basin. It consists of interbedded sandstones and shales, with a number of coal seams near the base. The formation is mainly exposed above tree-line but some scattered outcrops are present along stream channels. The Kootenay Formation is capped by Cadomin Conglomerate of Lower Cretaceous age, which is the basal member of the Blairmore Formation.

Pleistocene and Recent deposits of varying thickness overlie in the bedrock (W.S.C., 1966-a; Stevenson, 1967). Glacial till is the most common surficial deposit in the basin and has an average thickness of 20 to 40 feet. The greater part of the till was deposited by the Kananaskis Valley Glacier. The upper limit of this till is at approximately the 7,200 foot M.S.L. contour. Kananaskis Valley till is a

light brownish grey, silty, calcareous till, containing a large amount of dolomitic limestone, sandstone, and quartzite rock fragments. Local, Mount Allan till occurs at the higher elevations. It is generally neutral to weakly acid in reaction, and contains a large percentage of platy and flaggy rock fragments. Geomorphic processes, inclusive of slumping and sheet flow, have resulted in thicker surficial deposits along the stream bottoms and in downvalley positions. Continuing processes of solifluction and cryoturbation are evident in the alpine area. In general, the surficial deposits tend to smooth out the humps and hollows of the underlying bedrock.

In general, groundwater in the basin is delineated by water table conditions. Groundwater recharge occurs in the spring and early summer by infiltration from snowmelt and rainfall. Depletion takes place gradually during late fall and winter to supply stream baseflow. The steeply-dipping water table is a subdued replica of the basin surface, with Marmot Creek and its tributaries acting as V-shaped drains. Contact springs and boggy areas have usually developed where the slope of the water table decreases more rapidly than the slope of the topographic surface.

A reconnaissance soil survey by Lindsay and Peters (1964) indicated the presence of five distinct soil types in Marmot Creek Basin: Bisequa Gray Wooded, Podzol, Regosol, Alpine Black and Organic. The well-drained soils follow a vertical zonation with Bisequa Gray Wooded at the lower elevations, passing through Podzols, to Regosols at the higher elevations.

The basin vegetation (Ogilvie, 1963) consists of mature, subalpine forest and alpine tundra with the tree line at about 7,500

feet M.S.L. Engelmann spruce (*Picea engelmannii*) and alpine fir (*Abies lasiocarpa*) are the dominant tree species in the forested area with lodgepole pine (*Pinus contorta* var. *latifolia*) a frequent and abundant concomitant. A fire, in 1936, destroyed the mature spruce-fir forest in the lower reaches of the basin. Since then, a dense young stand of lodgepole pine has become established. Near timberline the forest becomes more open and has a high admixture of whitebark pine (*Pinus albicaulus*) and alpine larch (*Larix lyallii*). The alpine tundra vegetation comprises a large number of sedges, grasses and forbs, of which *Kobresia* spp., *Elymus* spp., and *Dryas* spp. are the most noteworthy.

Streeter Creek Basin. The basin is located in the Porcupine Hills about 70 miles S.S.W. of Calgary, Alberta, in Tp 13, R 1, W 5. Total area of the basin is 2.31 square miles. There are three sub-basins (Fig. 4) having areas of 0.2, 0.35, and 0.53 square miles, respectively. Elevations in the basin range from 4,300 feet M.S.L. to 5,450 feet M.S.L. The mean elevation per basin area is at 4,805 feet. The basin has a northerly aspect and the overall topography is moderately sloping. Variations in slopes range from 5 - 50 per cent.

The basin was selected in November, 1963. Instrumentation for collection of hydrometeorological data commenced in 1964 (W.S.C., 1966-b). The average annual precipitation is approximately 20 inches. Precipitation in late spring and early summer accounts for 50 to 75 per cent of the total annual precipitation. The maximum rainfall intensity was 0.91 in./hour on June 9th, 1967.

The minimum temperature on record is -29°F. which occurred

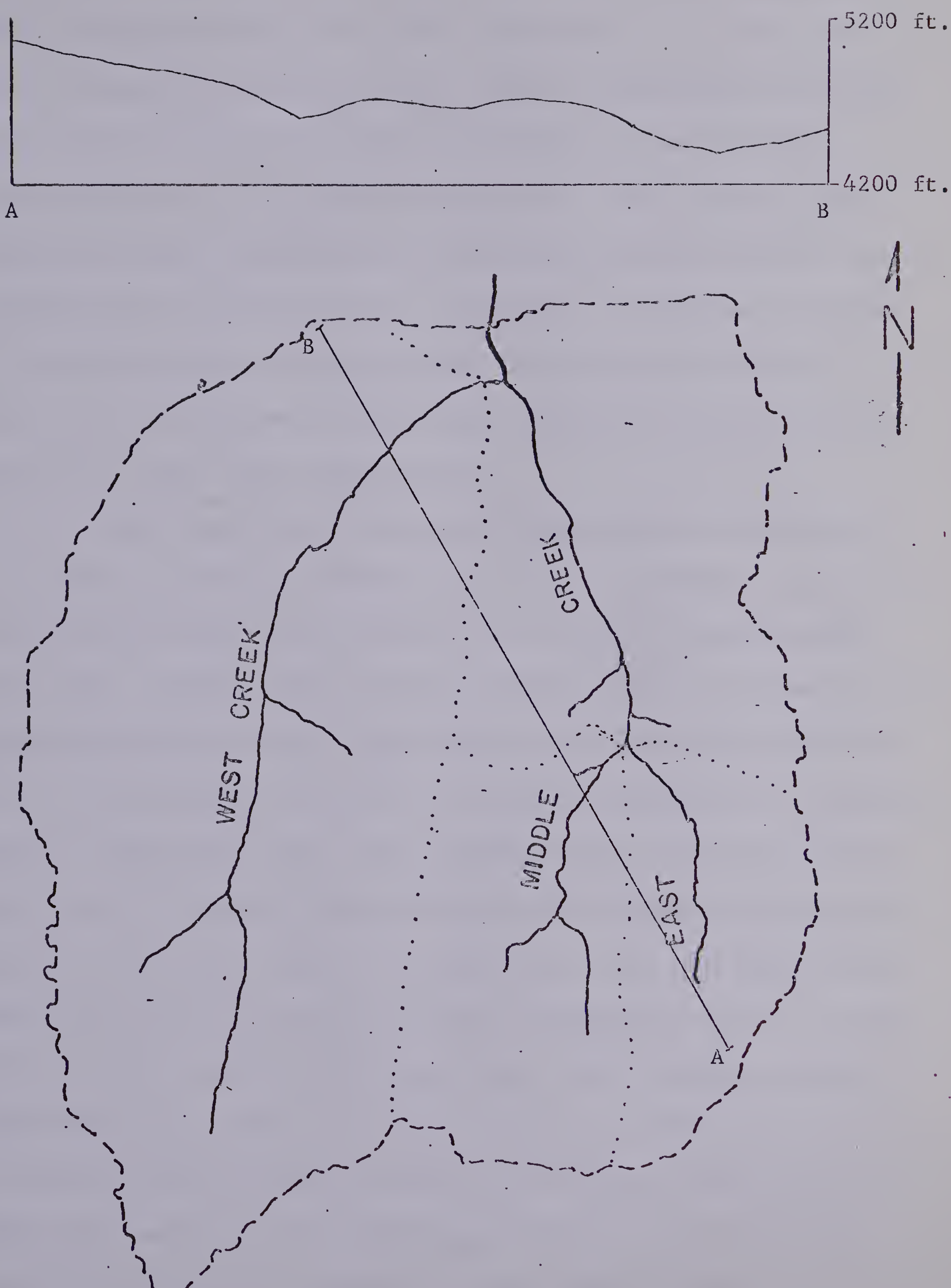


Figure 4. Streeter Creek Basin.

in January, 1966. A maximum temperature of 85°F. was measured on August 24th, 1966. The mean yearly maximum and minimum temperature during 1966 was 47.8°F. and 26.2°F., respectively. The frost-free period during 1966 was over 60 days. Nightly temperature inversions appear to be of common occurrence in the basin, as indicated by minimum temperature and relative humidity data. For instance, the mean 1966 minimum temperature at a valley-bottom meteorological station, elevation about 4,500 feet M.S.L., was 24.0°F. as compared to 29.4°F. at a ridge-top station being at an elevation of about 4,750 feet M.S.L. Corresponding mean 1966 relative humidity for these locations were 67 and 57 per cent, respectively.

Soil temperature measurements are obtained by thermisters. The thermister sites have either a grass or forest vegetation cover and are situated in pairs on an east and a west aspect at approximately 4,500 feet. The 1966 results (W.S.C., 1966-b) show that the mean yearly temperature under grassland vegetation at 72 inches depth was 41.2°F. on a west-facing slope and 41.7°F. on an east-facing slope. Corresponding soil temperatures under aspen vegetation were 40.1°F. and 40.6°F., respectively. Temperature variations at the soil-humus interface were more pronounced than those at 72 inches depth. The west-facing slope under grass had a mean yearly interface temperature of 44.2°F. as compared to 46.0°F. for the east-facing slope. Corresponding interface temperatures under aspen forest were 41.7°F. and 40.8°F., respectively. The 1966 maximum and minimum temperature at the soil-humus interface under grass vegetation were 70.4°F. and 16.7°F. at the west-facing location and 81.0°F. and 20.8°F. at the east-facing location. A

maximum of 65.8°F. was recorded under aspen forest at both the west and the east-facing location. The 1966 minimum temperature at the west-facing location was 22.3°F. and at the east-facing location 19.4°F.

Measurement of mean daily stream discharge and monthly flow at the main stem stream gauge control did not commence until July, 1966. The 1966 data of the sub-basin controls showed that mean daily discharge and monthly flow was highest during June and lowest in January and February. Middle Streeter Creek has a slightly higher mean monthly discharge than East Streeter Creek. The West Streeter Creek has a much lower mean monthly discharge than either Middle or East Streeter Creek and is dry for the greater part of the year. Measurements of spring discharge showed that the mean daily discharge and monthly flow followed a trend similar to that of the tributaries. Middle Spring, located on an east-facing slope in the Middle sub-basin, had more than twice the discharge of either East Spring or West Spring, which are located, respectively, on a west-facing slope in the East sub-basin and on an east-facing slope in the West sub-basin.

Suspended sediment content in water samples taken at the main stem and tributary controls was very low. Date of occurrence of maximum suspended sediment content does not seem to coincide for the measuring stations. Maximum content at the main weir was .008 gm/1. on August 10th, 1966, at a discharge of 0.34 c.f.s. The surface waters have an appreciable mineral content, most of which is due to the hardness salts, calcium and magnesium bicarbonates. Average total hardness in the main creek during July and August, 1966, was 261 ppm. and pH values ranged from 8.0 to 8.3 during this period.

The bedrock geology of Streeter Creek Basin consists of sedimentary rocks of Early Tertiary age, belonging to the Porcupine Hills formation (Douglas, 1950). This formation consists of fine to coarse-grained, flaggy to massive, crossbedded, argillaceous sandstone and has a shallow easterly dip. The dip is between 10° and 15° east and the strike is north 10° west. A well-developed set of near vertical joints strike NNW and ENE. Bedrock outcrops are common, particularly at the higher basin elevations.

Surficial deposits of Recent and Pleistocene age usually overlie the bedrock (W.S.C., 1966-b). Glacial tills are the most common surficial deposits. This material ranges in thickness from less than 20 feet at the ridge-tops to approximately 100 feet at the base of Streeter basin. Both Laurentide and Cordilleran ice have glaciated the area, as is evident from the presence of small granite and limestone erratics, respectively. Stalker (1957) states that Laurentide glaciers covered the whole area, up to points 5,400 feet above sea-level, and that Laurentide drift covers Cordilleran drift throughout the basin.

Groundwater conditions in the basin appear to be affected by the open bedrock fractures, the east-dip of the bedrock, and the depth of valley-incision into the bedrock. The existence of open bedrock in the upper parts of the basin and the great number of springs originating in bedrock exposures and occurring down the slopes indicate that the bedrock is actively involved in the storage and conductance of groundwater. Deeper incision into the east-dipping Porcupine Hills Formation by the West Streeter Creek may have resulted in greater groundwater underflow and consequently less stream flow as compared to the Middle

and East Streeter Creeks.

Vegetative cover consists of forests and grasslands, each of which is divisible into several sub-types. The forest cover sub-types recognized are trembling aspen (Populus tremuloides), black poplar (Populus trichocarpa), Douglas fir (Pseudotsuga taxifolia variety glauca), and willow-birch (Salix spp. - Betula occidentalis). Trembling aspen is the dominant forest cover sub-type, having Calamagrostis canadensis as the dominant understory component. Associations of trembling aspen and rose (Rosa acicularis), trembling aspen and fire-weed (Epilobium angustifolium), and trembling aspen and pinegrass (Calamagrostis canadensis) are deliniated in the basin (Johnson, 1964). In general, the aspen cover is less than 50 feet in height and has no commercial value for wood products.

Grasslands are divisible into three sub-types. The first of these is dominated by fescue (Festuca idahoensis) and oatgrass (Danthonia parryi). It occurs primarily on the upper slopes and ridge-crests. The second sub-type is dominated by timothy (Phleum pratense) and is confined to valley bottoms. The third sub-type is composed chiefly of herbs, notably Monarda fistulose, Rosa acicularis, Galium boreale, Achillea mille-folium, Stipa columbiana, and Agropyron subsecundum. This sub-type appears to be restricted to slopes.

Deer Creek Basin. The basin is located in the Red Deer River Valley about 60 miles N.W. of Calgary, Alberta, in Tp 31, R 8 and 9, W 5. There are three sub-basins, as shown in Figure 5. The total experiment-

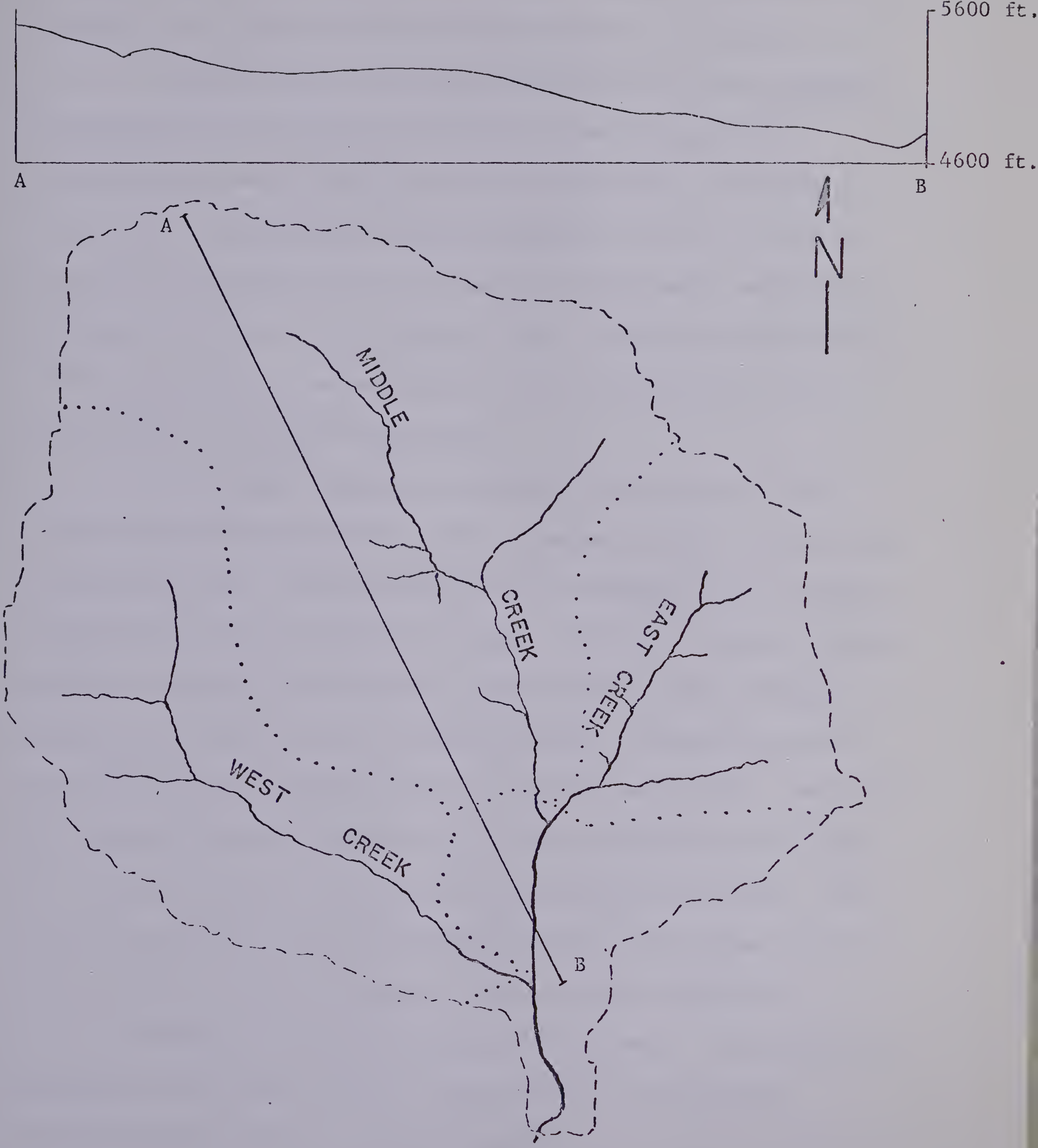


Figure 5. Deer Creek Basin.

al area is approximately 2.5 square miles. Elevations in the basin range from about 4,500 feet M.S.L. to approximately 5,600 feet M.S.L. The basin has a southerly aspect and is moderately sloping.

The basin was tentatively accepted in early 1966, pending the results of a preliminary assessment in the ensuing year. Instrumentation and collection of meteorological data commenced in June, 1966. Average total annual precipitation was 21.6 inches in 1967 and 24.7 inches in 1968. The average total summer rainfall was 5.7 inches in 1967 and 11.9 inches in 1968. Total summer rainfall in 1968 varied from 11.3 inches near the 4,600 foot contour to about 12.4 inches at the 5,400 foot contour.

The minimum temperature recorded in the basin was -44°F. and occurred on December 27th, 1968. A maximum of 89°F. was recorded on July 9th, 1968. Summer temperatures are somewhat lower and winter temperatures tend to be higher at higher elevations. The mean monthly maximum temperature for July, 1968, was 69.0°F. at the 4,600 foot contour and 63.5°F. at the 5,400 foot contour. Corresponding mean monthly maxima for January, 1968, were 18.9°F. and 21.3°F., respectively. Mean yearly maxima and minima were 39.7°F. and 18.5°F. at the 4,600 foot contour and 43.5°F. and 24.4°F. at the 5,400 foot contour. The higher mean monthly minima throughout the year at the upper elevation indicate that temperature inversions are of common occurrence.

Hydrometric data are lacking for the basin. Instrumentation commenced in the fall of 1968. Installation of a groundwater instrumentation network is also in progress.

The basin is underlain by the Paskapoo Formation of Early Cenozoic age (Ollerenshaw, 1966). This formation is composed of

massive, greenish-gray and gray, brown weathering sandstone; green and gray siltstone; rubbly green and gray mudstone; fine-grained gray calcareous sandstone; minor silty shale; and minor conglomerate lenses. A dominantly-sandstone zone of the Paskapoo Formation underlies the upper part of the basin, and a dominantly-shale zone underlies the lower half of the basin. The basin is located at the west rim of a syncline and the bedrock is dipping east.

Surficial materials, chiefly of Pleistocene age, cover the greater part of the basin (Stevenson, 1969). Laurentide glacial till is the most common surficial deposit and is generally less than 10 feet thick. Glacio-fluvial and glacio-lacustrine deposits are present to a limited extent in the lower part of the basin.

Vegetative cover consists primarily of lodgepole pine (*Pinus contorta*) forest. Lesser areas may be dominated by white spruce (*Picea glauca*), poplar (*Populus* spp.), or sedge (*Carex* spp.), or a brome - wheatgrass - oatgrass (*Bromus*/*Agropyron*/*Avena hookeri*) association (MacKenzie - Grieve, 1968). The forest understory may consist of shrubs, forbs, grasses, mosses, or a combination of these. Dominant understory components include alder (*Alnus* spp.), buffalo berry (*Shepherdia* spp.), small-bush cranberry (*Vaccinium vitis-idea*), blueberry (*Vaccinium scoparium*), feather moss (*Hylocomium* spp.), willow (*Salix* spp.), and rye-grass (*Elymus* spp.). Understory cover dominancy has resulted in the deliniation of 7 lodgepole pine, 2 poplar, and 2 white spruce associations.

IV. METHODS

Soil Survey

Detailed soil surveys were conducted on the three experimental Watershed Basins located in southwestern Alberta. These surveys were carried out on a grid basis, with soil descriptions made at intervals of 10 chains. In Marmot Creek and Deer Creek Basin, the grid surveys were made to coincide with a grid-system that was previously established for forest-inventory purposes.

Colour: Munsell Soil Color Charts (1954) were used as a guide in describing the colours of the soils.

Classification: The soils were classified according to the Canadian System of Soil Classification (N.S.S.C., 1968).

Soil Mapping

Field mapping: The soils were mapped in the field on the basis of soil series, type, or phase. Soil boundary lines were determined along the grid traverse lines and projected between the lines of traverse with the use of aerial photographs.

Computer mapping: The computer program described by Kirby and Chow (1969) was used for computer mapping. The program was modified to accommodate a larger number of codes and was adapted to - O.S./360 FORTRAN H compilation.

Sampling

A number of soil profiles, representative of mapping units, were sampled in each of these basins for chemical and physical

characterization. Pits were excavated at the sampling sites which exposed an area larger than the dimensions of the pedon. The soils were sampled according to horizon sequence within the pedon.

Some of the profiles sampled in each basin were selected as being representative of the soil pattern. These profiles were investigated in greater detail than the profiles which are representative of mapping units.

The collected samples were air-dried and then oven-dried at 60°C. for 12 hours. The soil peds were then crushed in a steel-roller mill to pass a 2 mm. sieve and stored in non-sealing screw top containers.

Physical Analyses

Mechanical analysis: The pipette method described by Toogood and Peters (1953) was used for mechanical analysis. Salts were removed from the soil with repeated washing; organic matter with H_2O_2; and calcium carbonate with the addition of 0.1 N HCl. Fine clay content was determined by evaporating an aliquot separated from the total clay fraction by centrifugation as outlined by Baver (1959). The method was modified, in some instances, to include sodium-citrate extraction prior to pipette analysis for size distribution determination of the silt and clay fractions.

Specific gravity: The air-comparison pycnometer method was used for specific gravity determinations.

Bulk density: Bulk density measurements were obtained according to the method described by Bradfield and modified by Lutz (1947). The cores used had an inside diameter of 2 inches. The bulk

density values reported are representative of the less than 2 mm soil fraction which was achieved as follows. After the samples were oven-dried and weighed, the material was ground and subsequently passed through a 2 mm sieve. The coarse skeleton fraction thus separated was weighed and this value was subtracted from the weight of the soil minus that of the core. The volume of the coarse skeleton was then determined by displacement of water in a graduated cylinder. Volume of coarse skeleton was subtracted from the volume of the core. Bulk density was then calculated using the weight and volume values obtained after subtraction of the respective coarse skeleton values.

Infiltration rate: The inundation method described by Kohnke (1938) was used for infiltration rate determination. The sixteen-compartment infiltration apparatus was modified to maintain a constant hydraulic head and steady water supply. A two-hole rubber stopper was placed on each measuring burette to accommodate insertion of 1/4 in. I.D. plastic tubing. One piece of tubing was directed along the outside of the burette into the infiltration compartment. Plastic tubing from the second stopper-hole led to a 10 gallon storage tank situated on top of the infiltrometer frame. In the case of the four measuring burettes, the water supply line was equipped with a clamp to facillitate measurement of the amount of infiltrated water.

Dispersion ratio: The susceptibility of the upper mineral soil horizon to water erosion was determined according to Middleton's (1930) dispersion ratio method.

Soil moisture analyses:

(a) Hygroscopic moisture was determined by oven drying samples overnight at 105^{o}C.

(b) 15 bars moisture was determined by the method of Richards (U.S. Salinity Laboratory Staff, 1954) using a pressure membrane apparatus with cellulose casing membrane. Soil that was passed through a 2 mm. sieve was placed in rubber retaining rings, 1 cm. in height and about 6 cm. in diameter.

(c) 1/3 bars moisture was obtained with the method of Richards (U.S. Salinity Laboratory Staff, 1954) which employs a pressure plate apparatus. The sieved soil was placed in rubber retaining rings having a height of 1 cm. and a diameter of about 6 cm.

(d) Saturation capacity was determined on soil that was passed through a 2 mm. sieve. The sample was placed in an aluminum foil dish and saturated to a paste. Saturation capacity was considered to be the loss in weight of the sample after drying to a constant weight at a temperature of 105°C.

Chemical Analyses

Soil reaction: pH values were determined on a saturated soil paste as outlined by Doughty (1941) using a Beckman model zeromatic pH meter equipped with a glass and a calomel electrode.

Total carbon: A Leco, model 577-100 carbon analyzer was used for the determination of total carbon. The samples were ground to pass a 60-mesh sieve before being placed in the induction furnace.

Total nitrogen: The Kjeldahl-Wilfarth-Gunning method (A.O.A.C., 1955) was used for the determination of total nitrogen. The catalyst used was HgO (0.41 g), $CuSO_4$ (0.08 g) and K_2SO_4 (9.9 g) packaged in a polyethylene bag and sold commercially as Kel-pak. The ammonia was collected in a 4% H_3BO_4 solution as suggested by Meeker

and Wagner (1933) and titrated against standardized H_2SO_4.

Calcium carbonate equivalent: A modification of the procedure described in A.O.A.C. (1955) was used to determine carbonate carbon. The CO_2 evolved by treating the sample with H_2SO_4 and $FeSO_4$ was absorbed in ascarite and determined gravimetrically.

Exchangeable cations and exchange capacity: Exchangeable cations were extracted from the sample with 1 N ammonium acetate adjusted to pH 7.0 as outlined in A.O.A.C. (1955). Exchangeable potassium and sodium were determined with the Perkin Elmer model 303 Atomic Absorption Spectrophotometer. Calcium and magnesium were determined titrametrically using standardized E.D.T.A. The cation exchange capacity was determined by extraction of adsorbed ammonia with 1 N NaCl and distillation of the extract was carried out according to the method outlined in A.O.A.C. (1955).

Exchange acidity: Exchange acidity was determined by leaching the soil with 0.5 N barium acetate adjusted to pH 7.0. The leachate was titrated with standardized sodium hydroxide as suggested by Brown (1943).

pH-dependent cation exchange capacity: The pH-dependent cation exchange capacity was obtained by taking the difference between the C.E.C. value determined with ammonium acetate and the sum of the cations extracted with 2 N NaCl (Clark, 1965). The results were expressed as per cent NaCl-extractable cations on the exchange complex.

Free iron and aluminum:

(a) The oxalate extraction method outlined by McKeague and Day (1966) was used for removal of amorphous iron and aluminum oxides.

Iron and aluminum in the extracts were determined colorimetrically.

(b) The dithionite-citrate-bicarbonate extraction method described by Jackson (1956) was used for the removal of both amorphous and crystalline material. Iron and aluminum in the extracts were determined colorimetrically using ortho-phenanthroline and ammonium aurin tricarboxylate (aluminon), respectively.

Total iron and aluminum: The method outlined by Pawluk (1966), involving Hf - HCl dissolution and spectrophotometric analysis, was used for determination of total iron and aluminum in clay fraction samples.

Amorphous material analysis: Clay fraction samples were treated by the sodium hydroxide method outlined by Hashimoto and Jackson (1960). Amorphous silica was determined by the colorimetric method described by Kilmar (1965) and amorphous aluminum was determined according to Hsu's (1963) method.

Mineralogical Analyses

Preparation of clay samples: Clay separation was carried out using the method outlined by Jackson (1956). Following fractionation, the clay samples were flocculated with $CaCl_2$; freeze-dried and stored in vials.

X-ray analysis of clay minerals: The clay samples were prepared for X-ray analysis according to the method of Kittrick (1961). A few drops of K-saturated or Mg-saturated clay suspension were placed on a glass slide, and allowed to dry by standing overnight. Ethylene glycol treatment of the air-dried mounted suspension was carried out

by placing the prepared slides in a saturated atmosphere of ethylene glycol. The glycolated slides of the K-saturated samples were then heated to 550°C. for 2 hours and stored in a desiccator prior to X-ray analysis. Additional analyses were performed on a number of K-saturated samples consisting of non-glycolation, and glycolation plus heat treatment at 100°C. and 300°C., respectively.

A Philips X-ray diffractometer with a high angle gonimeter was used for identification of the clay minerals present. The x-ray generator was operated at 40 k.v. and 20 m.a., using CuKα radiation with a nickel filter. Scanning speed was one degree 2θ per minute. and chart speed 1 cm. per minute. Recorder settings were 200 cps., 8 tc., and 0 zs. for all diffractograms other than those of some Mg-saturated samples. A recorder setting of 400 cps., 8 tc., and 0 zs. was used for all Mg-saturated fine clay samples and for (Mg) samples which show a distinct break in their diffraction pattern as indicated by a line normal to the pattern line.

Micropedological Analyses

Microscopic investigations: A number of samples were investigated with the aid of a microscope to determine the geologic origin of the surficial deposit. A dilute HCl solution was used to remove free iron and aluminum oxides prior to analysis. The sample was then suspended in olive oil, refractive index 1.46, and investigated with the aid of a microscope.

Thin sections:

(a) Undisturbed samples were obtained by spading out a large mass of soil followed by trimming to a size that would fit into

a padded 400 cc. cardboard container. The sample was allowed to air dry in the containers after which clods of 30 to 35 cc. were removed by knife trimming. Each small clod was placed in a 50 cc. crucible with the natural orientation being maintained.

(b) Impregnation and preparation were carried out according to the method of Acton and modified by Dumanski (1964).

(c) Photography of the thin sections was carried out with a Carl Zeiss model 51871 photomicroscope. Kodak High Speed Ektachrome type B film was used in the camera. Two D 50 gray filters were used over the artificial light source. Film speed setting was kept at 7 for said film and light settings varied between VII and X depending on the field illumination. The auxillary ring lens was set at 1.25 X, the occular lens at 3.2 X, and 6.3 X and 3.2 X objective lenses were employed.

V. RESULTS AND DISCUSSION

Land Characteristics and Patterns

A: Marmot Creek Basin

Land. Marmot Creek Basin is characterized by very steep topography, subalpine and alpine vegetation, relatively low precipitation, and the presence of Quaternary surficial deposits. Glacial till is the dominant surficial deposit and is derived from different source areas. Till deposited by the Kananaskis Valley Glacier has as an approximate, upper boundary the 7,200 foot contour, while Mount Allan till is normally found above this contour line. Postglacial colluvium deposits are of common occurrence throughout the basin. These deposits vary in thickness from a few inches to several feet, depending on degree of slope and source material. A postglacial volcanic ash deposit occurs throughout the greater part of the basin and is normally found as a band between the colluvium and the till deposits.

Kananaskis Valley till deposits were observed to be separable on the basis of degree of compaction and soil reaction. A compacted and a non-compacted phase of this till were recognized in the basin (Appendix I-A). The compacted till phase is found primarily in the lower reaches of the basin and is characterized by neutral to alkaline pH values, Gray Luvisol soils, and lodgepole pine (*Pinus contorta*) vegetation. Illite is the dominant clay mineral present with kaolinite occurring in minor amounts (Fig. 10, p. 76).

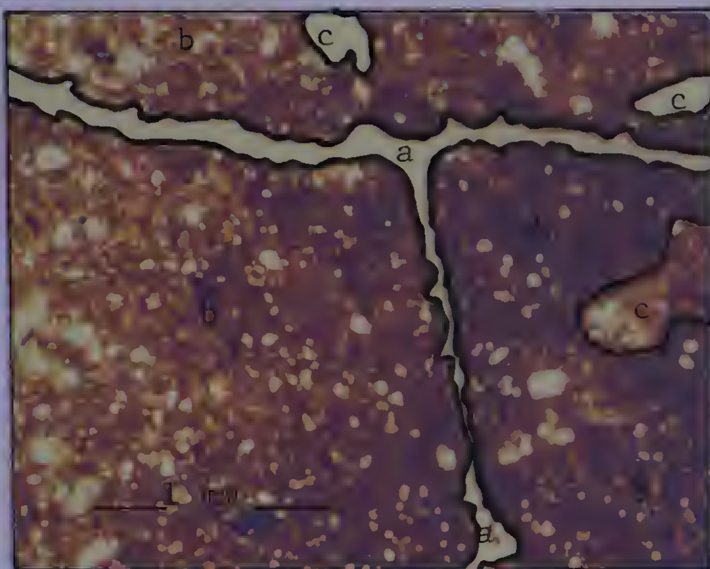
The non-compacted phase of the Kananaskis Valley till is usually found at higher elevations than the compacted phase. It is characterized by acid pH values, presence of Podzolic and Brunisolic

soils, and supports a forest vegetation in which Engelmann spruce (Picea engelmannii) and alpine fir (Abies lasiocarpa) are the dominant tree species. This till-phase tends to become less compacted with increase in elevation as is evident from the photomicrographs (Plate 1, Sites M9, M33 and M5). Both till phases contain a large admixture of organic material. Dominant clay minerals in the non-compacted phase of the Kananaskis Valley till are a vermiculite-like clay which does not expand upon K-saturation and illite (Fig. 11, p. 81).

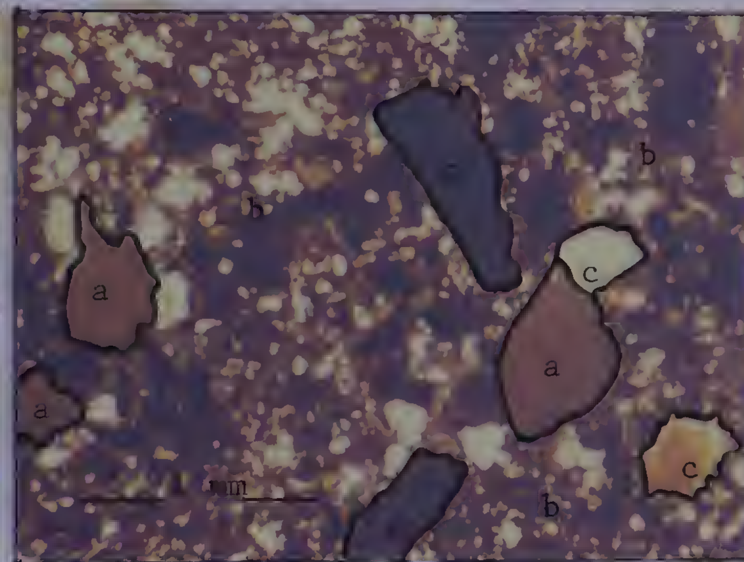
Local, Mount Allan till is characterized by an acid to neutral pH and a high admixture of channery rock fragments. Vegetation types associated with this till are alpine larch forest below tree line and alpine tundra above tree line. Corresponding soil associations are, respectively, Dystric Brunisols and Humic Gleysols. Kaolinite, illite and a vermiculite-like clay that does not expand upon K-saturation are the dominant clay minerals in this till (Fig. 16, p. 98). The dominance of kaolinite and illite clay minerals in this till is supported by their presence in the source material (Carrigy and Mellon, 1964). Mount Allan till is quite loose and contains large amounts of organic plasmic material (Plate 1, Site M25).

Postglacial volcanic ash deposits were found at varying depths within the soil profiles. These deposits vary in thickness, normally not exceeding 4 inches, and are of common occurrence throughout most of the basin (Fig. 6). Their thicknesses and positions in the profiles at a number of sampling sites are reported in Table 1. The results show that, in well-drained soils, the ash layer occupies the upper B horizon position in the solum, which agrees with observations from elsewhere (Smith, Okazaki, and Aarstad, 1968). Analyses for deter-

Plate 1. Photomicrographs of thin sections from C horizons in Marmot Creek Basin

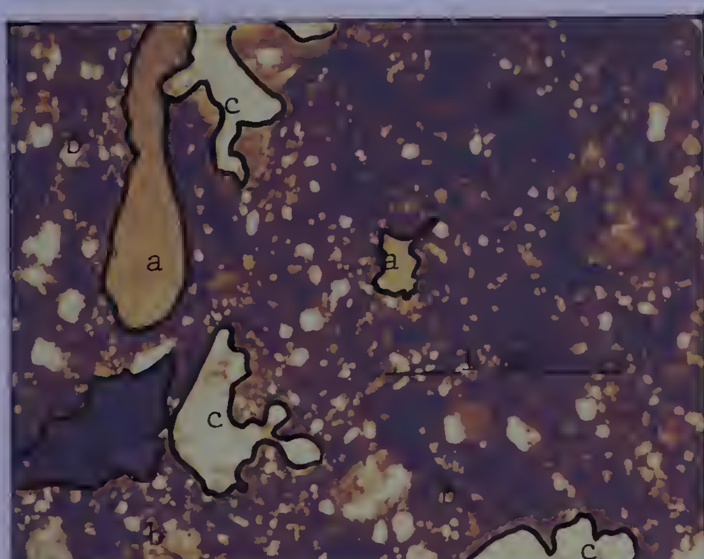


IIC horizon at Site M3 (⟶)

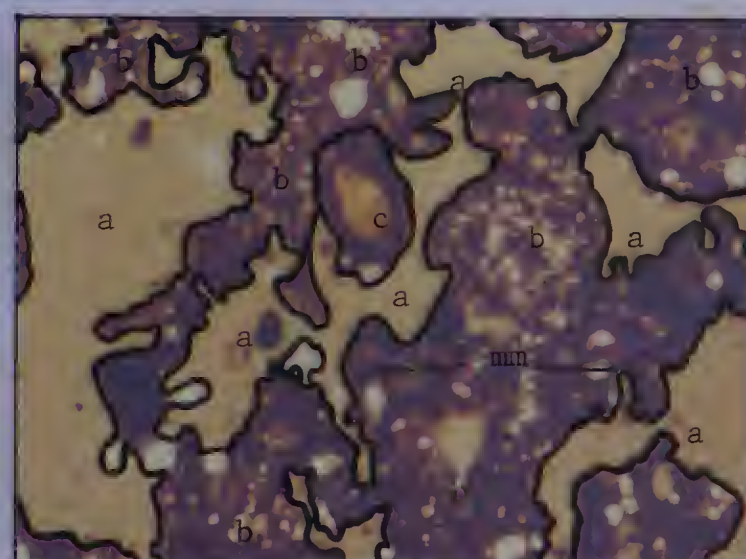


IVBC horizon at site M9 (⟶)

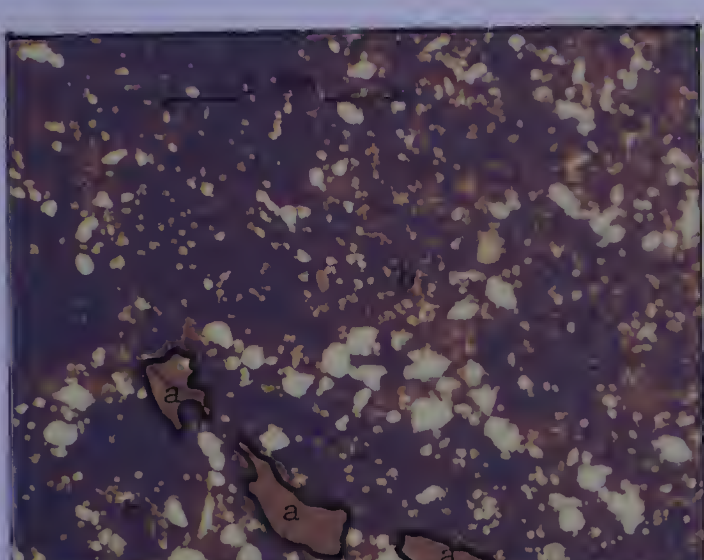
LEGEND: a). voids b). matrix c). large minerals



IIIC horizon at site M33 (⟶)

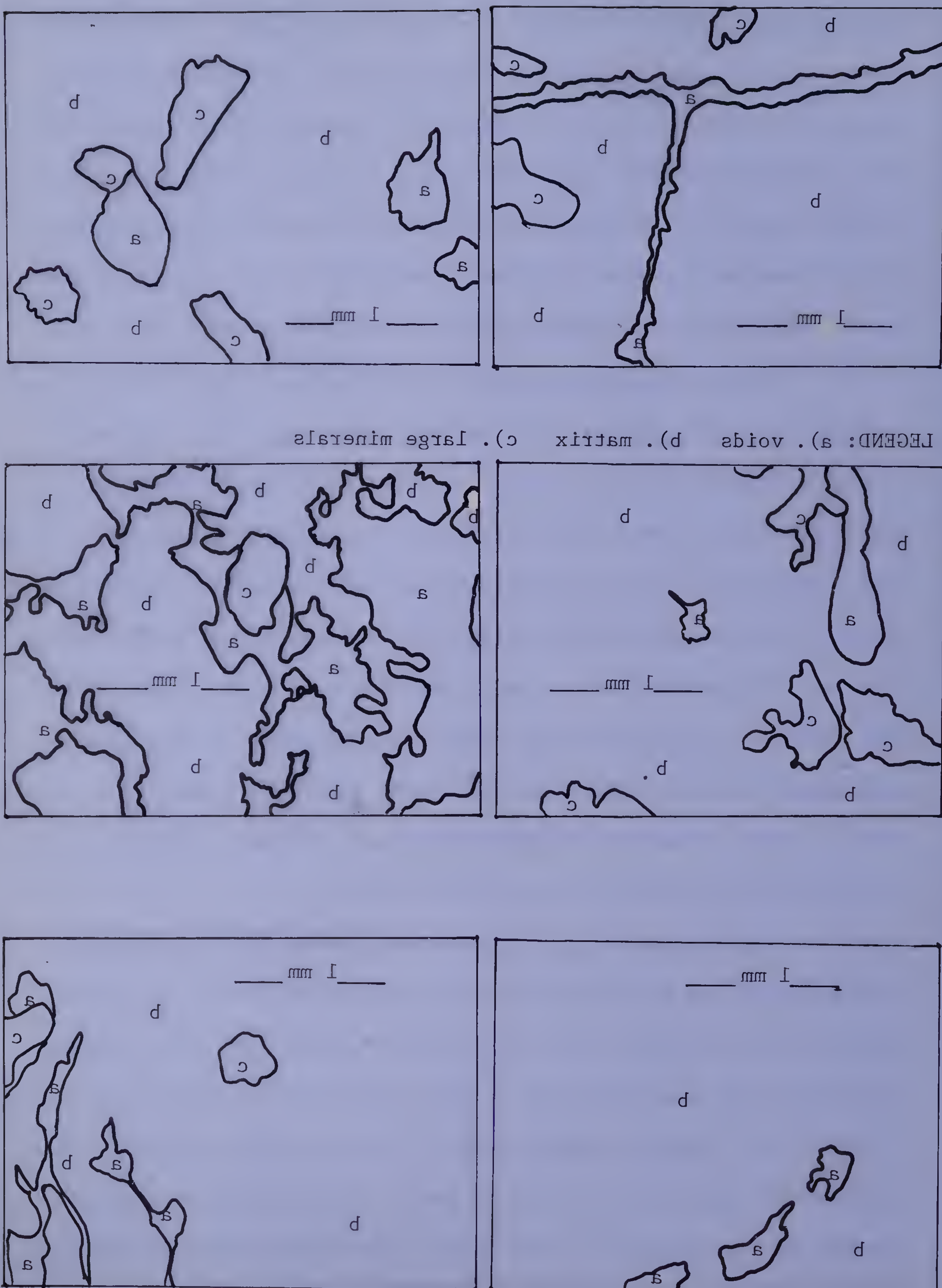


C horizon at site M5 (⟶)



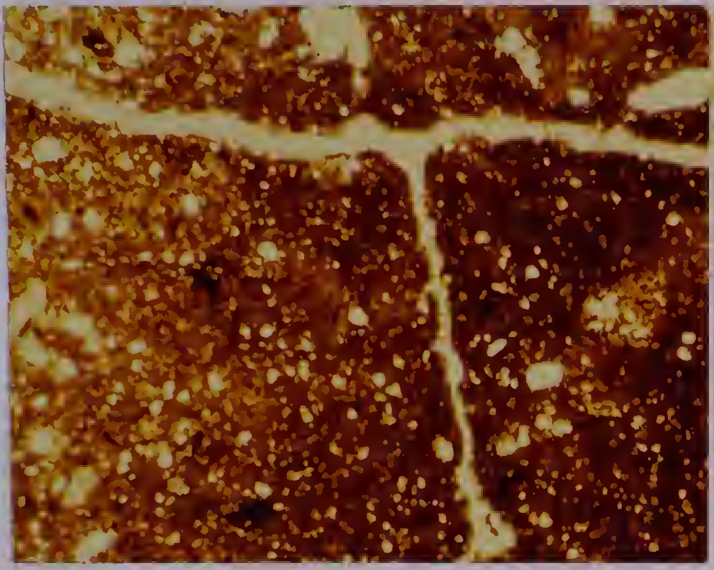
IIC horizon at site M25 (⟶)

IIC horizon at site M36 (⟶)

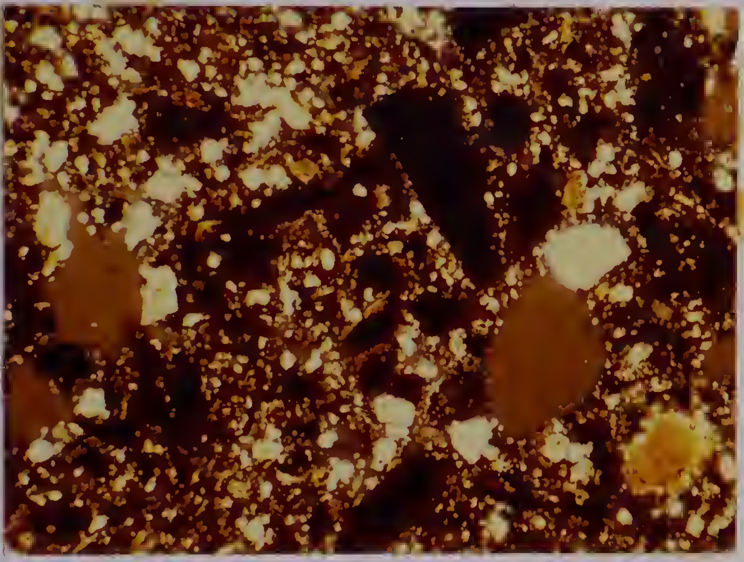


LEGEND: a). voids b). matrix c). large minerals

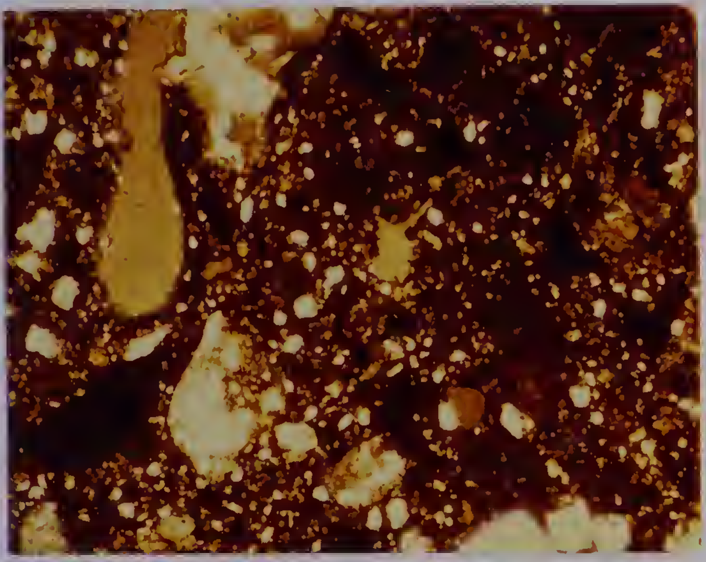
Plate 1. Photomicrographs of thin sections from C horizons in Marmot Creek Basin



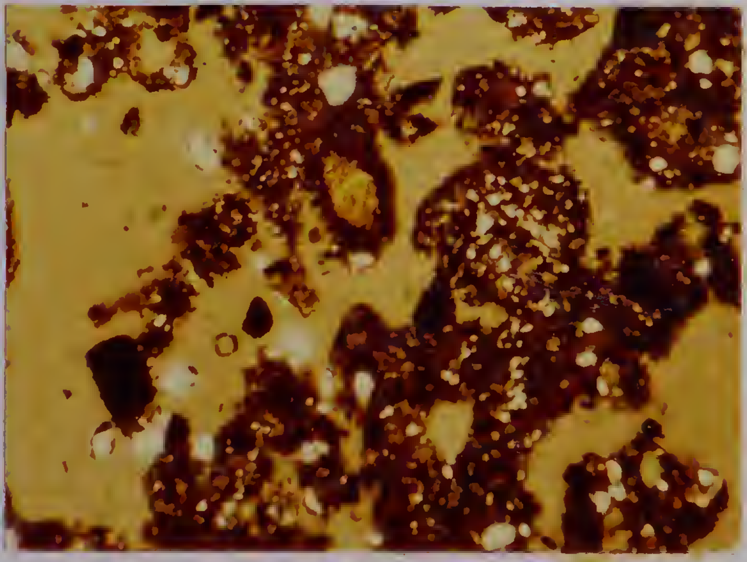
IIC horizon at Site M3 (⟶)



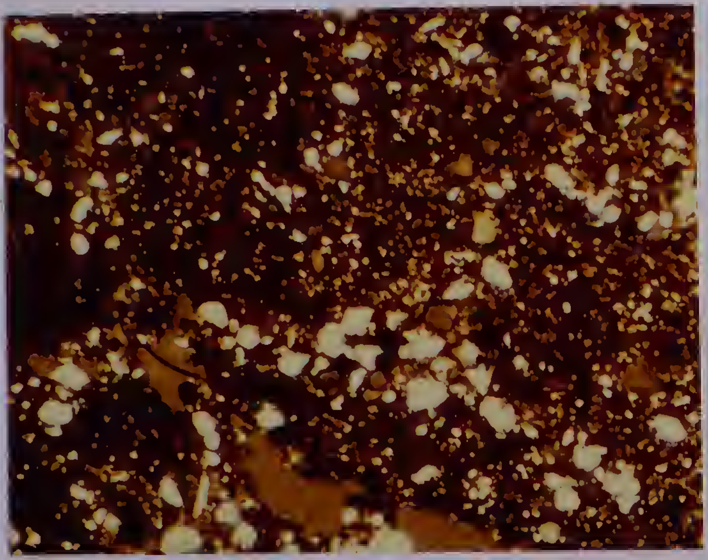
IVBC horizon at site M9 (⟶)



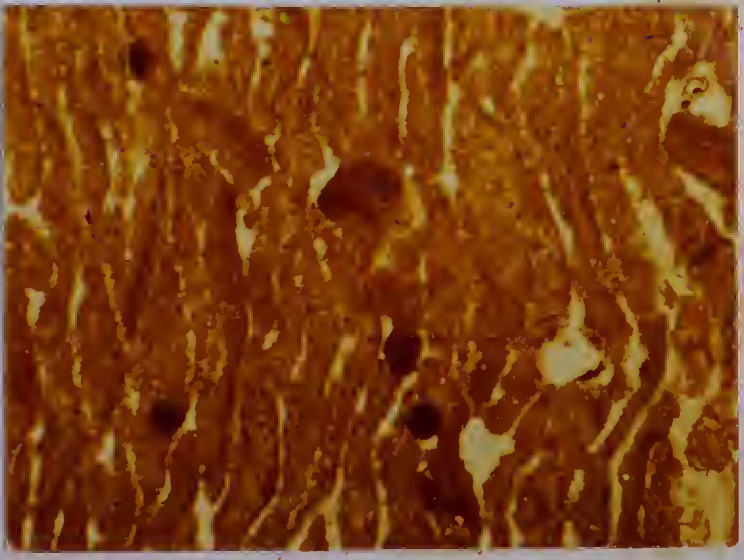
IIIC horizon at site M33 (⟶)



C horizon at site M5 (⟶)



IIC horizon at site M25 (⟶)



IIC horizon at site M36 (⟶)

DESCRIPTION OF PLATE 1

The photomicrographs of the C horizons depict the presence of 4 kinds of fabric (Kubiena, 1938; Brewer, 1964). The IIC horizon at site 3 has a very dense matrix.. A blocky microstructure is delineated by the small vertical pores and the smaller, discontinuous, horizontal pores. Skeleton grains are small and uniformly distributed. Some concentration of plasma is evident along the pore channels. The site 9 IVBC horizon, the site 33 IIIC horizon and the site 5 C horizon are comparable in the density of their matrix. Organic material is a prominent constituent of the plasma and is randomly distributed throughout the matrix. Skeleton grains are completely enclosed by the plasma. The small size and uniform distribution of the skeleton grain and the inclusion of more organic material distinguishes the site 5 C horizon material from that at sites 9 and 33.

The photomicrograph of the site 25 C horizon depicts a rather loose soil matrix containing large amounts of organic plasmic material. Skeleton grains are small and uniformly distributed throughout the matrix. Some of these grains exist as separate entities but most are intimately associated with plasmic material. Decomposed organic plasmic material tends to be concentrated along the voids.

The photomicrograph of the IIC horizon at site 36 shows a banded type fabric. Concentration of plasma in bands near the top of the plates is evident. Skeleton grains are small in size and are uniformly distributed. These grains do not occur as separate entities, although the skeleton fraction of the plates is not very dense.

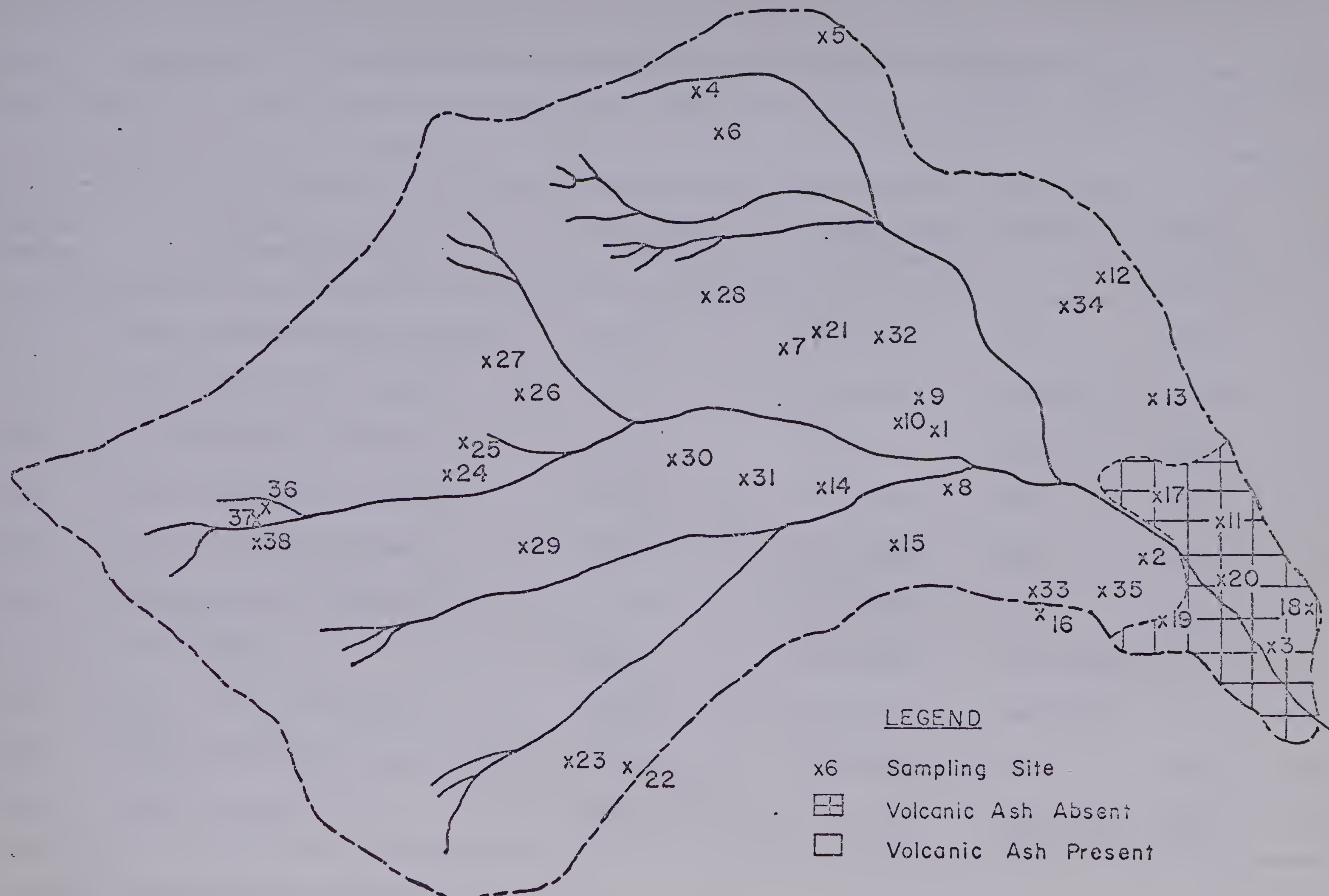


Figure 6. Sampling sites and volcanic ash distribution in Marmot Creek Basin

TABLE I. SAMPLING SITE CHARACTERISTICS AND THICKNESS AND POSITION OF ASSOCIATED VOLCANIC ASH LAYERS

Site					Volcanic Ash	
Profile Number	Profile Classification	Elevation (ft.)	Topography Slope/Aspect	Drainage	Horizon	Depth (cm)'
M1	Peaty Carbonated Rego Gleysol	5840	7%, SE	poor	IIIC"	35-48
M9	Orthic Ferro-Humic Podzol	5860	21%, SSW	mod-well	IIIBfl"	8-18
M12	Mini Ferro-Humic Podzol	6200	6%, E	well	IIBfl	4-9
M15	Orthic Ferro-Humic Podzol	6140	18%, NNW	well	IIBfl	4-14
M16	Mini Ferro-Humic Podzol	5850	21%, ENE	well	IIBfl	6-14
M22	Degraded Dystric Brunisol	7020	22%, NE	well	IIBfl	10-22
M31	Terric Fibrisol	6150	13%, ENE	very poor	C"	6-16
M33	Orthic Eutric Brunisol	5940	14%, NE	imperfect	Bf	0-8
M35	Brunisolic Gray Luvisol	5820	10%, NE	well	II(Bf)	3-13
M36	Cumulic Regosol	7600	NE	imperfect	IIC"+	48-100+

" sample submitted for source identification

+ composite sample, representing eight distinct layers of erosionally deposited ash

' depth below mineral surface

mination of the volcanic ash source have shown it to be Mazama in origin (Smith and Westgate, 1969).

Volcanic ash deposits are most readily identified by the presence of glass shards and pumice fragments (Powers and Wilcox, 1964). Ash deposits in the basin are characterized, furthermore, by a concentration of medium, silt-size material (Fig. 7, 8 and 9) and by the relative absence of clay minerals in apparently-unaltered volcanic ash C horizons (Fig. 12, p. 83 ; Fig. 13, p. 84). The observed platy macro-structure of such ash layers is substantiated by the banded-type of fabric evident on the photomicrograph of the IIC horizon at site M36 (Plate 1) and on those of ash-derived Bf horizons (Plate 2, p. 66).

Postglacial colluvial deposits were observed to be separable on the basis of source material. Colluvium derived from till, residuum, and volcanic ash deposits were recognized in the basin as well as mixed aeolian and till colluvium (Appendix I-A). Residual colluvial deposits are common above timber line and occur on very steep slopes below rock outcrops in the forested region of the basin. Deposits comprised of ash and till colluvium are generally found in strongly sloping, imperfectly drained locations. Till and ash derived colluvium have analytical characteristics similar to their source material. Till colluvium is generally looser than the till deposits and has fewer and smaller sized coarse skeleton material (Appendix I-B). Ash colluvium is characterized by a varied appearance resulting from iron concentration, the presence of minor amounts of coarse skeleton and pronounced sorting. Deposits consisting of a mixture of till and ash colluvium generally have the characteristics of the till component. Residual colluvium is characterized by large amounts of channery, slope-oriented rock frag-

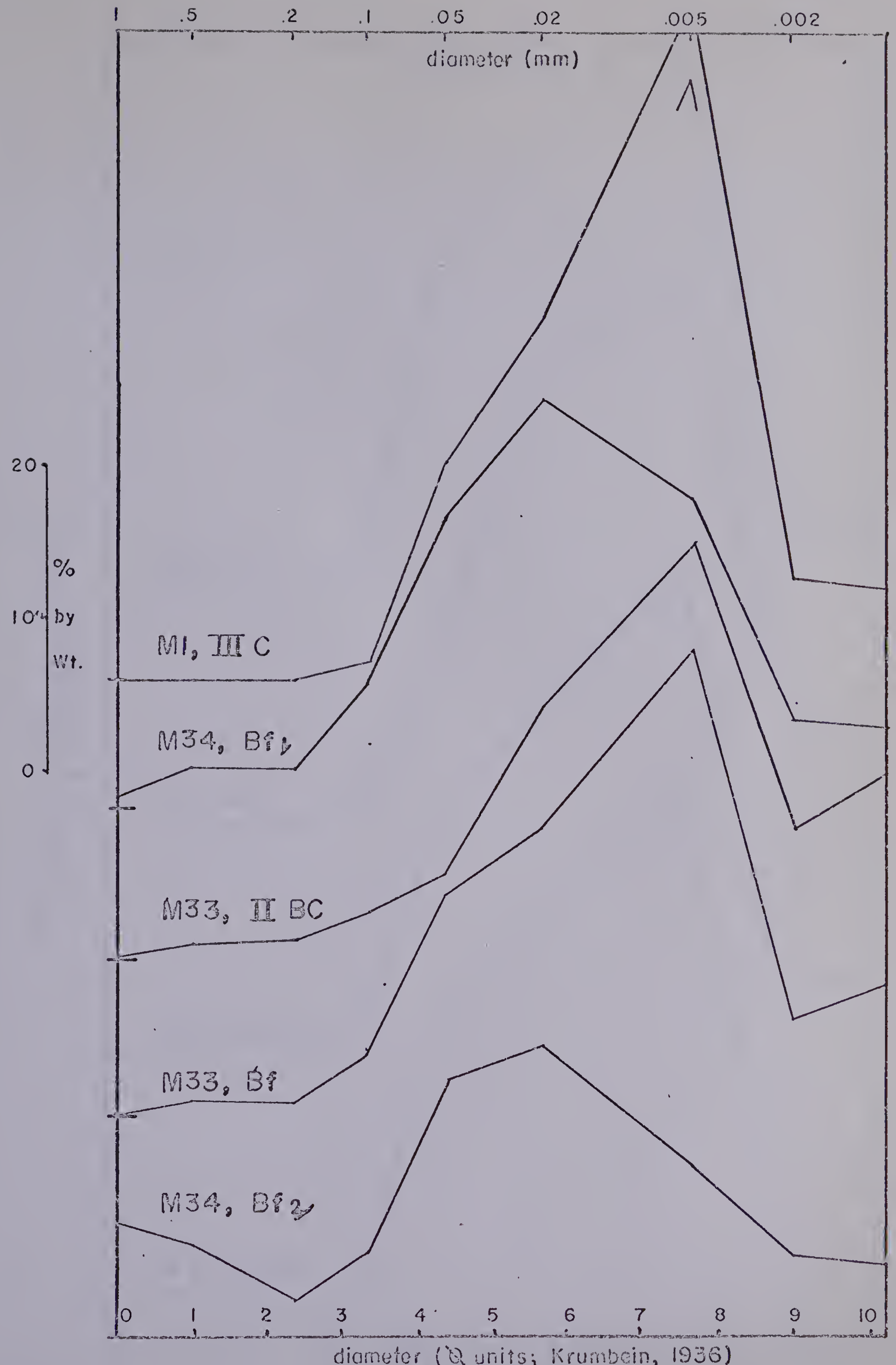


Figure 7. Particle size distributions of selected horizons from some soils of Marmot Creek Basin.

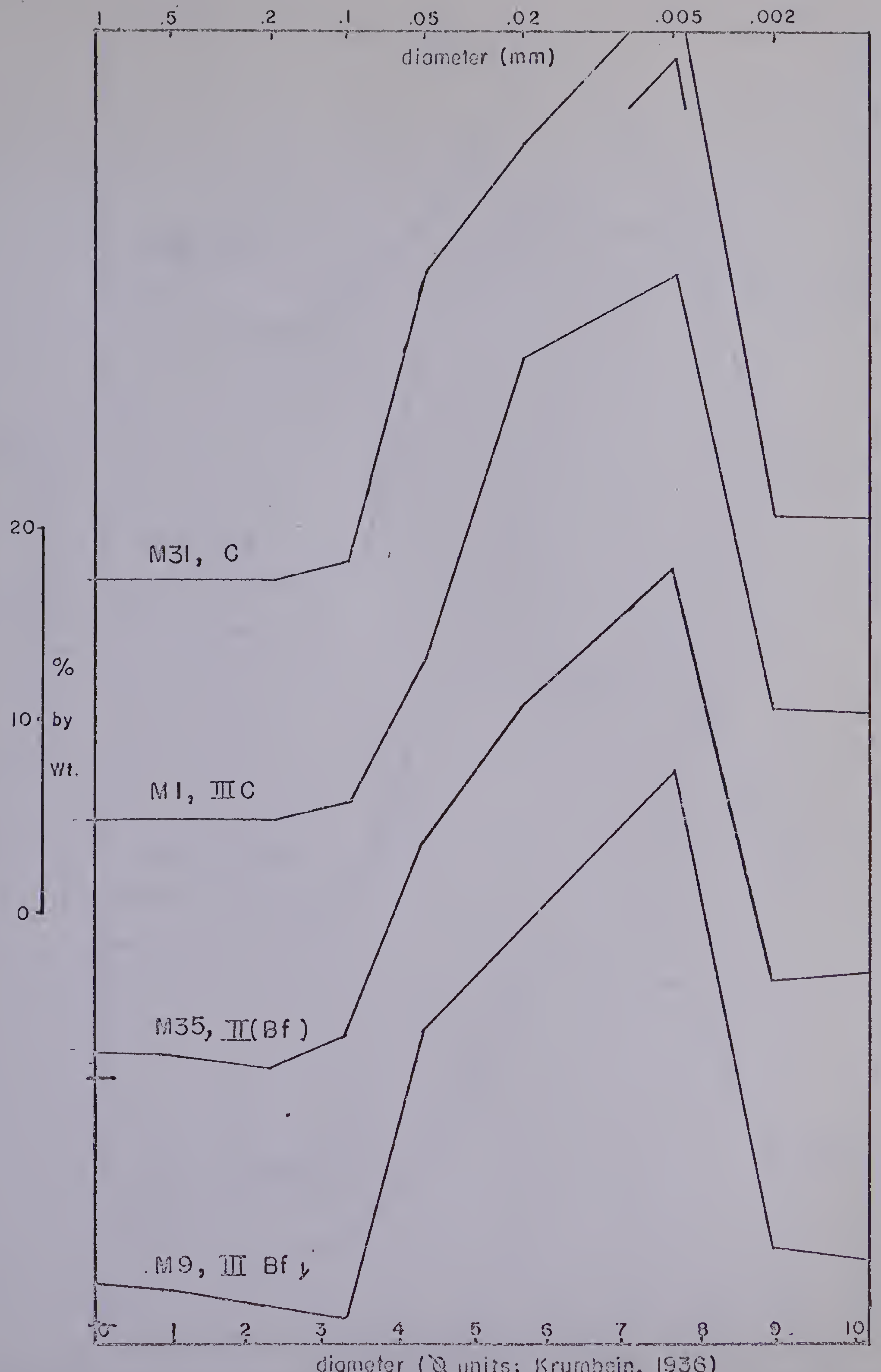


Figure 8. Particle size distribution of selected horizons from some soils of Marmot Creek Basin.

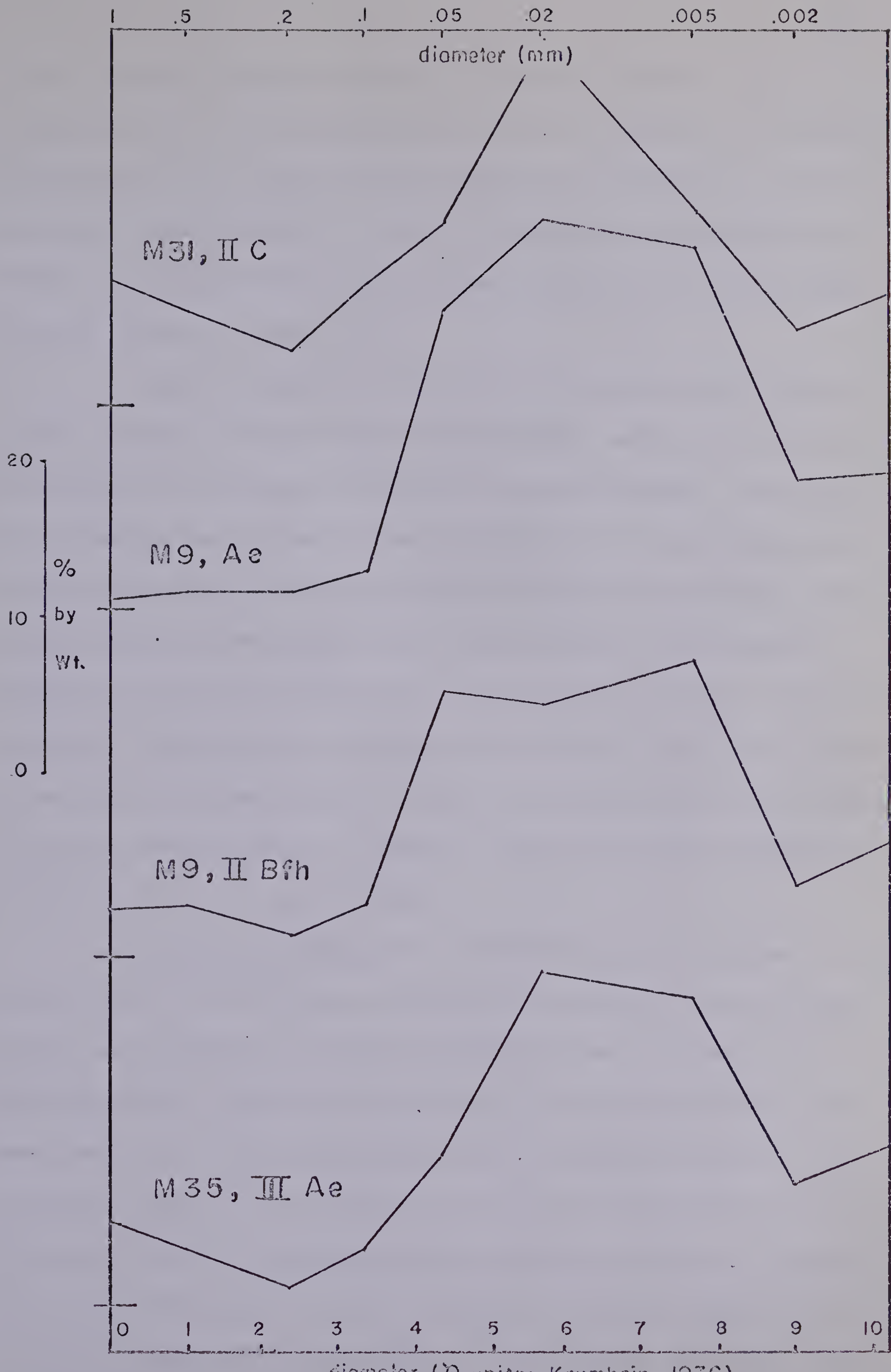


Figure 9. Particle size distributions of selected horizon samples from some soils of Marmot Creek Basin.

ments where the deposit is close to the source location. Deposits at a distance from the source tend to be sorted. Kaolinite, non-expandable-K vermiculite, and illite are the dominant clay minerals in residual colluvial deposits (Fig. 15, p. 94). In general, such deposits are very loose as is evident on the photomicrograph of the site M6, Ah2 horizon (Plate 3, p. 68).

Alluvial deposits are limited in extent and occur along the stream channels. These deposits are generally moderately sorted and can be separated on the basis of particle size distribution. Two types of such deposits were recognized in the basin, the one consisting dominantly of sand and silt sized material and the other consisting dominantly of gravel and stones which is characteristic of lag deposits. Mappable areas of the sandy alluvium are found in the lower reaches of the basin. Lag deposits are found at the bottom of very steep slopes along Middle and Cabin Creeks. Elevations at which these lag deposits occur are approximately the 6,500 ft. contour for Cabin Creek and the 6,200 ft. contour for Middle Creek.

Lacustrine deposits were encountered in two locations in the basin; namely, in the cirque, which is the headwaters area of Middle Creek, and easterly of the Middle and Twin Creeks confluence area. These lacustrine deposits are relatively thin, dark in colour, compact, and high in clay content (Appendix I-B, sites 24 and 33). The lacustrine deposit in the cirque is less than one inch thick and is found overlying till but buried under more than one foot of postglacial colluvium. The deposit easterly from the tributaries confluence area is about 5 inches thick and occurs as a band between Kananaskis Valley till and Mazama ash.

Weathered shale was found to be the parent material of some soils in the lower part of the basin. This material is of pedogenic significance only when the topography is moderately sloping. It is characterized by strong macro-structure and is highly compact. The photomicrograph of the IIC horizon at site M3 (Plate 1) substantiates this high degree of compaction.

Soils. The enclosed soil map of Marmot Creek Basin presents an outline of the soils occurring in the survey area. Soil groupings are according to Subgroup or Subgroup-Class classification, except for soils belonging to the Gleysolic Order. Gleysolic soils are delineated on the basis of their Great Group classification. A total of 19 such soil groupings are outlined on the map, ranging from Lithosol to Orthic Ferro-Humic Podzol. Location of the soil sampling sites in the survey area are shown on Figure 6. Detailed morphological descriptions and analytical results for each of the sampled profiles are presented in Appendix I-B.

The soil map shows that the well-drained soils follow a vertical zonation. Well-drained soils in the lower reaches of the basin belong to the Gray Luvisol Great Group. With an increase in elevation, the Gray Luvisol soil zone gives way, progressively, to a Ferro-Humic Podzol zone, a Dystric Brunisol zone and finally to a Regosol soil zone. The zonation of these well-drained soils corresponds closely to the pattern on non-calcareous parent material described by Jeffrey, *et al*. (1968).

The Gray Luvisol soil zone is dominated by Brunisolic Gray Luvisols; Orthic Gray Luvisols being of minor significance. Poorly-

drained positions within this soil zone are occupied by Rego Gleysol soils.

Mini Ferro-Humic Podzols are the dominant well-drained soils within the Ferro-Humic Podzol soil zone. Minor areas of Orthic Ferro-Humic Podzols are also outlined in this soil zone; although, where present, they normally occur as the dominant member of soil complexes. Orthic Eutric Brunisols are found in the imperfectly-drained positions of the Ferro-Humic Podzol zone, while Terric Fibrisols occur in the poorly-drained locations.

The Dystric Brunisol soil zone is the largest soil zone in the basin. Two subgroups of this Great Soil Group have been delineated on the soil map, each of which was further separated into two classes. Soils belonging to the Degraded Dystric Brunisol Subgroup are found immediately above the Ferro-Humic Podzol zone. Class A of this Subgroup refers to soils having a well expressed profile morphology and distinct accumulation of free Fe and Al in the B horizon as opposed to the Class B soils. The latter soils tend to approach the characteristics of soils known as Cryptopodzolic Rankers in Europe (Carbiener, 1963). Soils belonging to Alpine Dystric Brunisol Subgroup occur in the vicinity of the tree-line. They are characterized by the presence of a chernozem-like Ah horizon and are delineated into Subgroup Classes on the basis of vegetative association. Class A occurs under forest in which alpine larch (*Larix lyallii*) is the dominant tree species, while Class B occurs under alpine tundra vegetation. Degraded Eutric Brunisols occupy minor areas in the Dystric Brunisol soil zone. These soils are confined to the steep slopes of the drainage pathways and are distinguished by the lack or weak development of the Bm horizon.

The Regosol soil zone contains soils belonging to the Orthic and the Cumulic Subgroups. Cumulic Regosols occur on steep slopes under grass vegetation (Elymus spp.) and are characterized by deep, non-chernozemic Ah horizons which are usually over 3 feet thick. Soils belonging to the Orthic Regosol Subgroup have been separated into Classes on the basis of presence or absence of a non-chernozemic Ah horizon. Orthic Regosols which have a non-chernozemic Ah horizon were formerly classified in the Deorcic Regosol Subgroup (N.S.S.C., 1965). Soil complexes are common in the Regosol soil zone. Poorly drained positions in this soil zone have soils which belong to the Humic Gleysol Great Group.

In general, imperfectly or poorly drained soils in the basin cannot be classified properly by the Canadian System of Soil Classification (N.S.S.C., 1968). Mottling and/or gleying are absent in such soils in the basin (Appendix I-B), thereby preventing their classification at either the (Gleyed) Subgroup or the (Gleysolic) Order Level. It is suggested, therefore, that drainage notations for soils of mountainous areas be established on the basis of their occurrence in potential ground water discharge or recharge areas. Such areas can be delineated on the basis of vegetative associations, geomorphology, and/or topographic conditions.

Morphological descriptions of well-drained soils in the basin (Appendix I-B) show a progressive decrease in degree of profile expression from the Ferro-Humic Podzol zone to the Regosol zone at the higher elevations. This decrease in profile development with increase in elevation is also reflected in the analytical soil characteristics (Appendix I-B). Horizon pH values are more uniform throughout the pro-

file at the higher than at the lower elevations. In general, the total carbon content in the L-H horizon decreases while total nitrogen content and total exchange capacity increase with elevation. Weathering of clay minerals decreases with increase in elevation as is indicated by the degree of expression of the 14 Å and the continuous 10 - 14 Å reflection on the Ae horizon diffractograms. These reflections are more complex on the diffractograms of the Ferro-Humic Podzol Ae horizon (Fig. 11, p. 81) as compared to the Alpine Dystric Brunisol Aeh horizon (Fig. 16, p. 98).

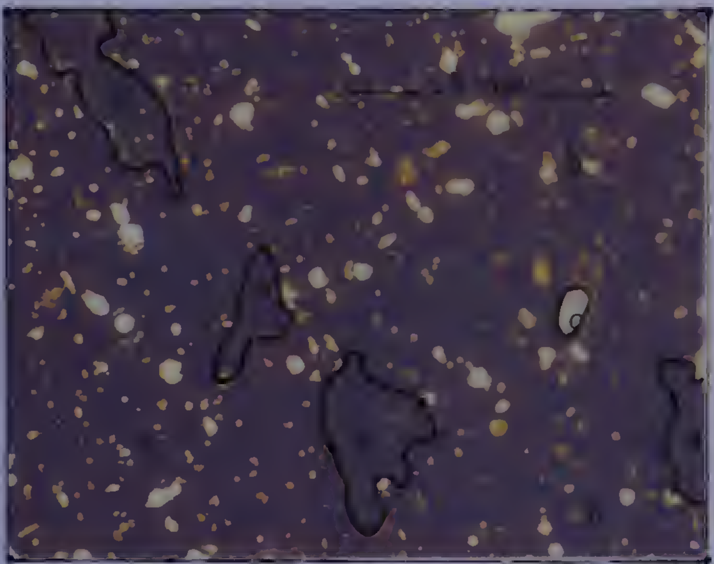
Decrease in morphological expression with increase in elevation is also evident from analytical and micropedological characteristics of the B horizons. The pH values of B horizons generally decrease while total carbon contents increase with elevation. Illuviation of colloidal material decreases with increase in elevation, as is evident from extractable iron and aluminum contents and from X-ray diffraction results. Accumulation of oxalate-extractable iron and aluminum is well expressed in Ferro-Humic Podzol soils and is less evident in Dystric Brunisols (Appendix I-B). Illuviation of clay into the B horizons is indicated on the diffraction patterns by the behavior of the 14 Å and the continuous 10 to 14 Å reflection. The 14 Å peak is indicative of vermiculite clays while the 10 to 14 Å reflection is indicative of interstratified 10 and 14 Å clay minerals (Brown, 1961; Jackson, 1956). Expansion of the 14 Å reflection upon K-saturation and glycolation was only observed for the upper B horizon of each soil profile, except in the case of the Degraded Dystric Brunisol (Ranker) profile. The diffractograms of the K-saturated and glycolated samples have not been presented since they

generally did not contribute to the interpretation of clay distributions. Photomicrographs of B horizons (Plate 2) show that these horizons become less dense and contain more organic plasmic material with increase in elevation. Concentration of plasma near voids or around skeleton grains is minimal in the Ferro-Humic Podzol soil and is poorly defined at higher elevations.

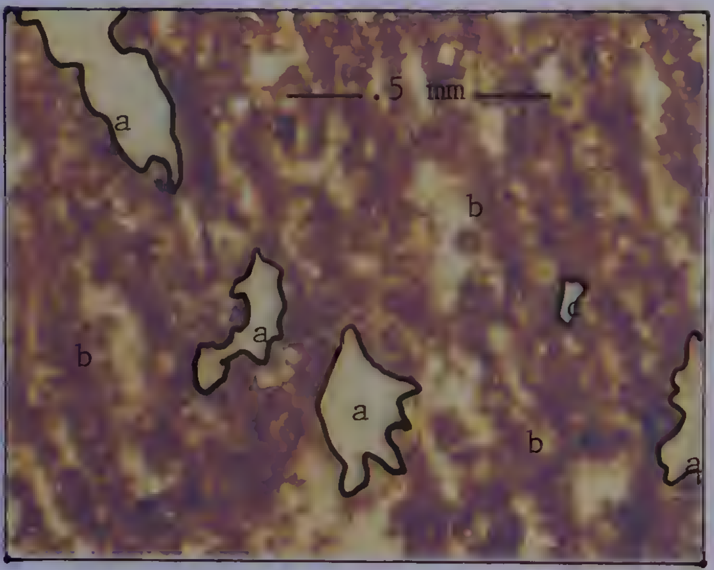
Morphological descriptions indicate that organic matter accumulation is a prominent soil feature at the higher basin elevations (Appendix I-B). Increase in organic matter content with increase in elevation is evident from the total carbon and nitrogen contents reported for the A horizons (Appendix I-B). The total exchange capacities of the A horizons follow a similar trend. Photomicrographs of Ah horizons from an Orthic Regosol, a Cumulic Regosol, and from both Classes of Alpine Dystric Brunisol provide visible evidence of organic matter accumulation (Plate 3). This soil humus is of the moder-type (Kubiena, 1938).

The decrease in variation of soil profile characteristics with increase in basin elevation agrees with results reported elsewhere for mountain soils (Duchaufour, 1965). Other characteristics of mountain soils include organic matter accumulation with increase in elevation and a moder-type of soil humus in soils from the alpine region. However, the occurrence of a colour Bm horizon in a number of soils located above the tree-line (Appendix I-B) is contrary to expectations. The presence of a Bm horizon in these soil profiles supports Griggs (1946) contention that the timberline in the Rocky Mountains is a climatic tension zone reflecting wind intensity and direction. As a consequence, these soils should be distinguished from those soils that are

Plate 2. Photomicrographs of thin sections from B horizons in Marmot Creek Basin

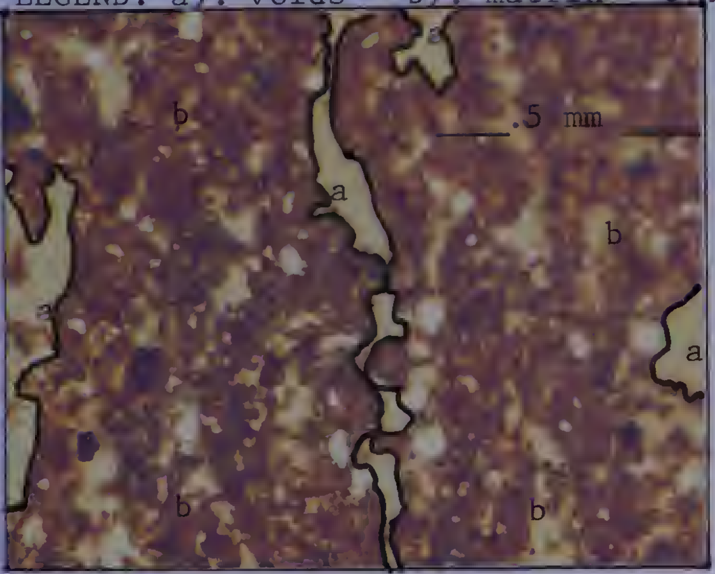


IIIBfl horizon at site M9 (—>) (pol. light)

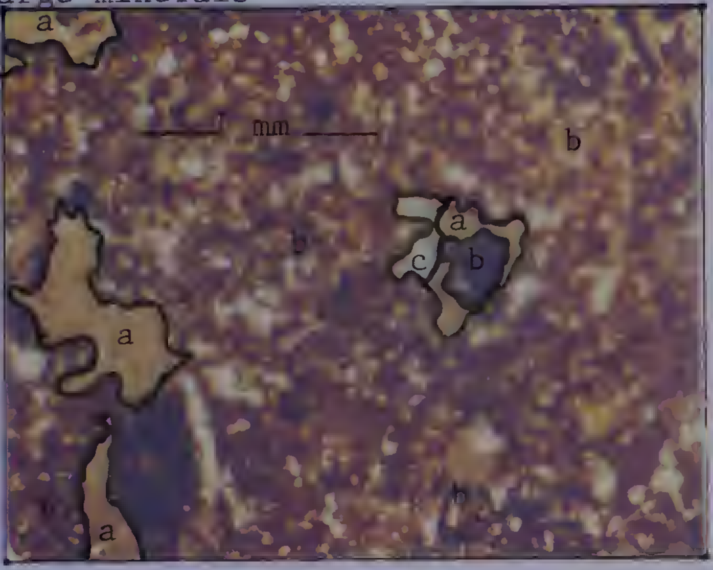


IIIBfl horizon at site M9 (——>)

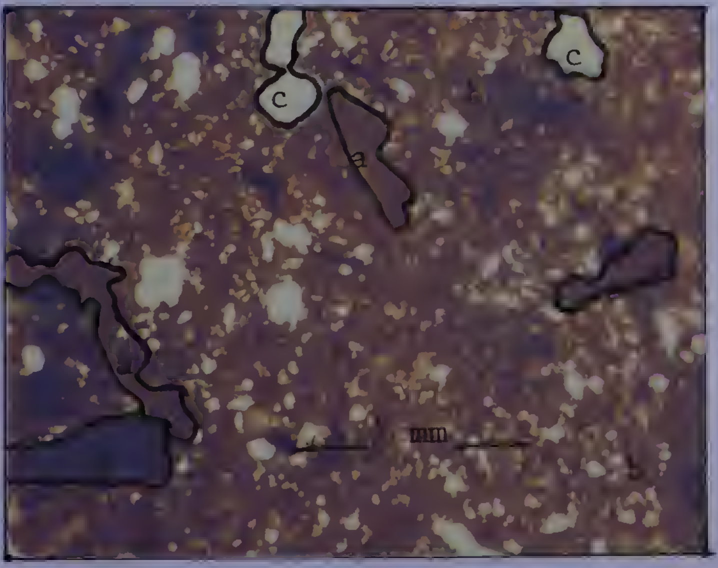
LEGEND: a). voids b). matrix c). large minerals



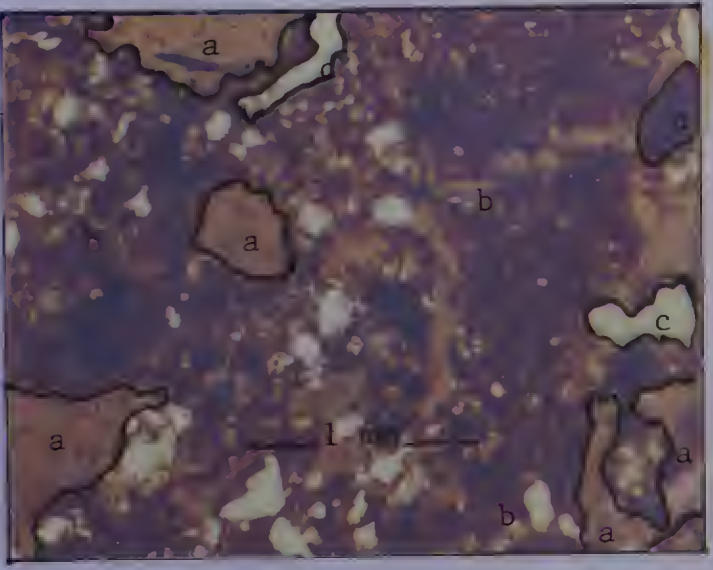
Bfl horizon at site M34 (——>)



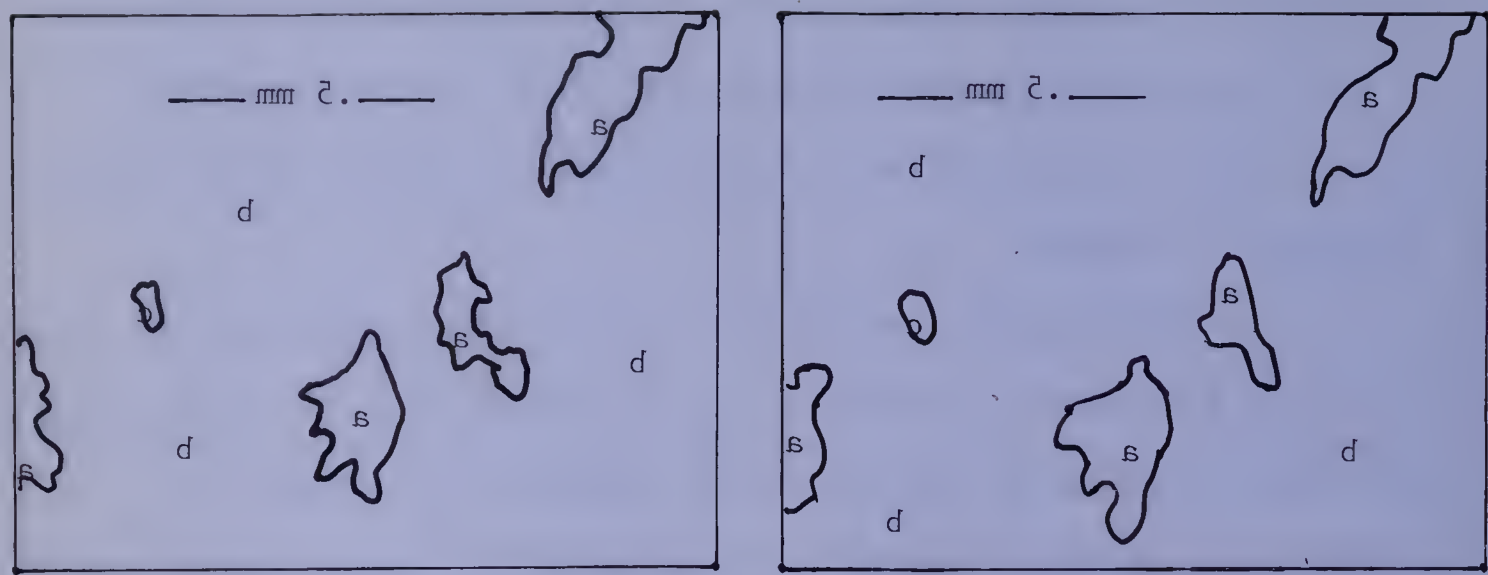
Bm horizon at site M33 (—>)



Bfh horizon at site M5 (——>)



Bfj horizon at site M25 (—>)



LEGEND: a). voids b). matrix c). large minerals

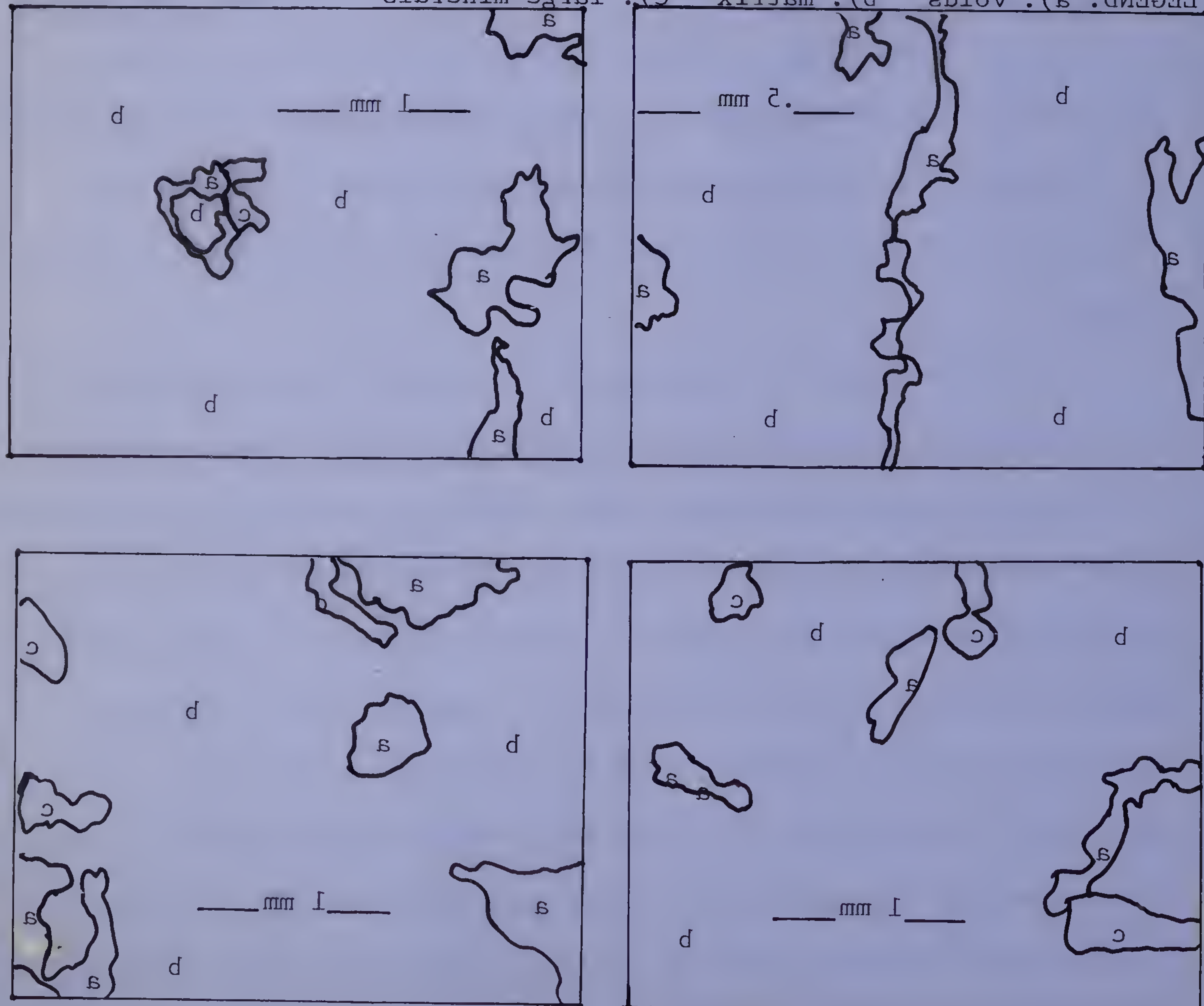
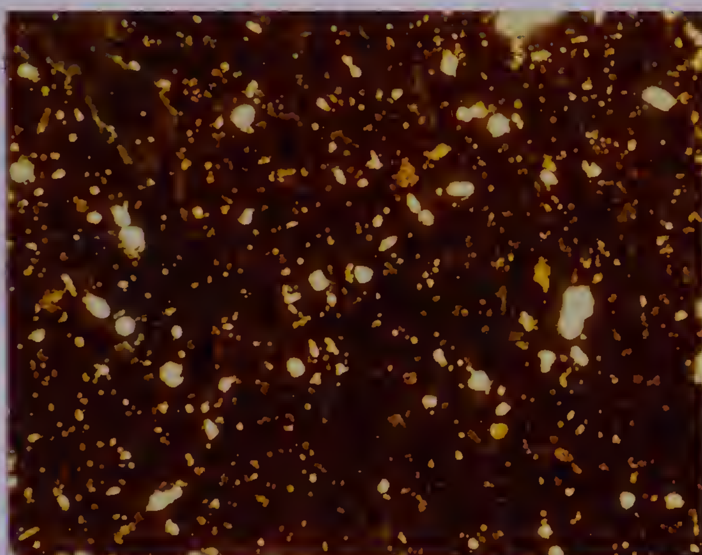
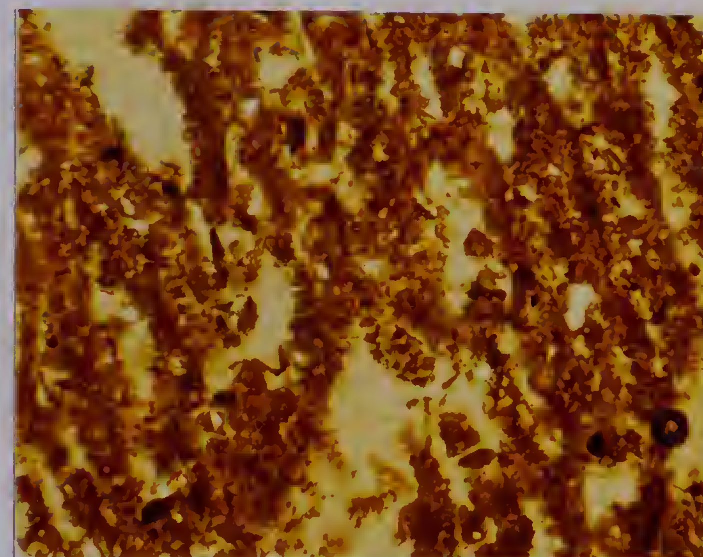


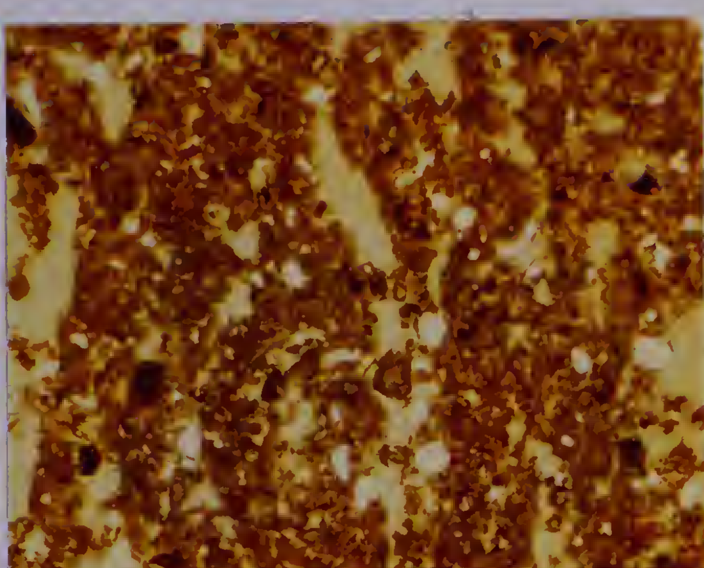
Plate 2. Photomicrographs of thin sections from B horizons in Marmot Creek Basin



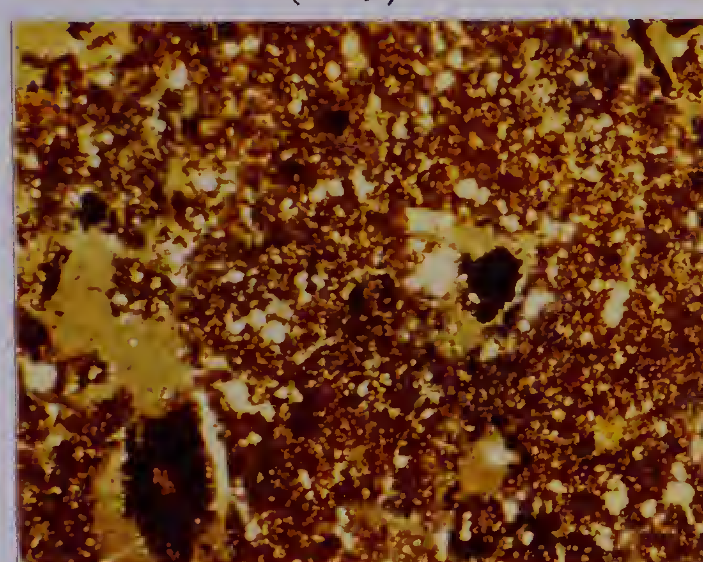
IIIBf1 horizon at site M9 (→) (pol. light)



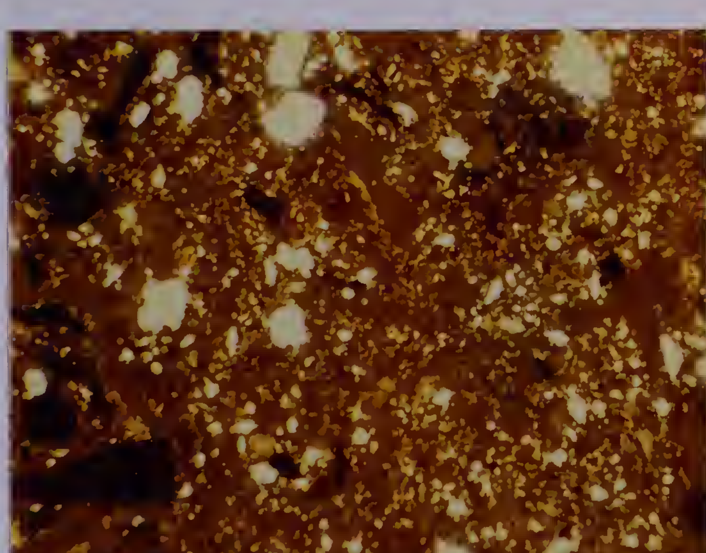
IIIBf1 horizon at site M9 (→)



Bf1 horizon at site M34 (→)



Bm horizon at site M33 (→)



Bfh horizon at site M5 (→)

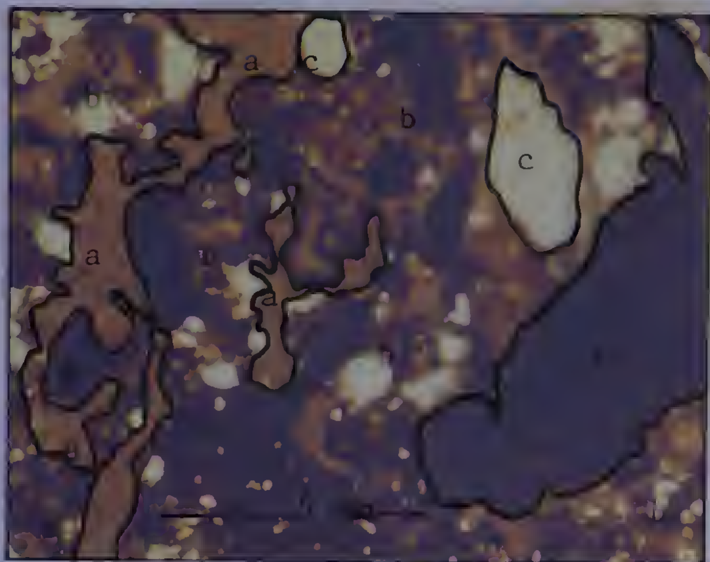
Bfj horizon at site M25 (→)

DESCRIPTION OF PLATE 2

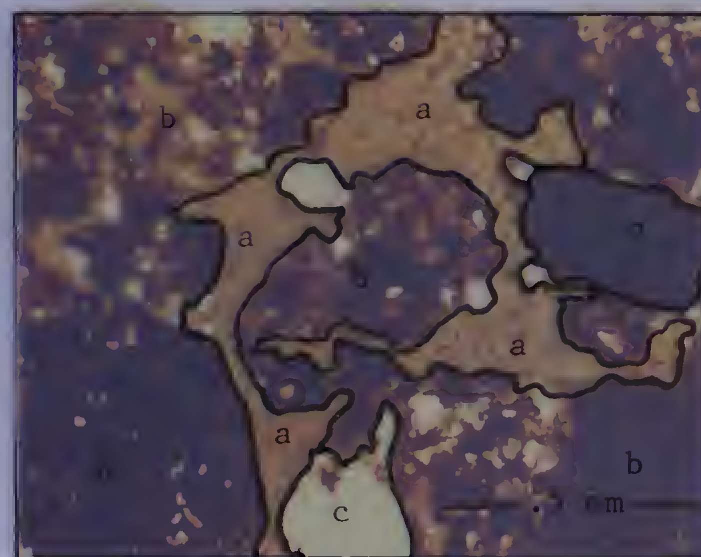
The thin sections of the B horizons are characterized by the yellowish colour of the plasmic material. The photomicrographs of the IIBfl horizon at site 9 and the Bfl at the site 34 have a banded type of fabric. Concentration of plasma in bands near the top of the plates is evident. The skeletal fraction of the plates is rather loose and consists predominantly of opaque material as is evident from the micrograph taken under polarized light. There is little evidence of a banded type of fabric in the Bm horizon at site 33.

The photomicrographs of the Bfh horizon at site 5 and Bfj horizon at site 25 show a generally loose soil matrix in which the larger skeleton grains are not bound to the plasmic material. The large amount of organic plasmic material is conspicuous for these two sites.

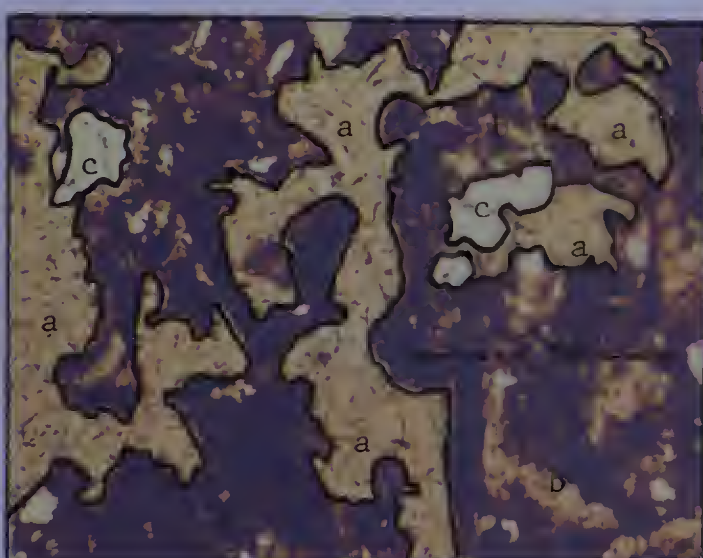
Plate 3. Photomicrographs of thin sections from Ah horizons in Marmot Creek Basin



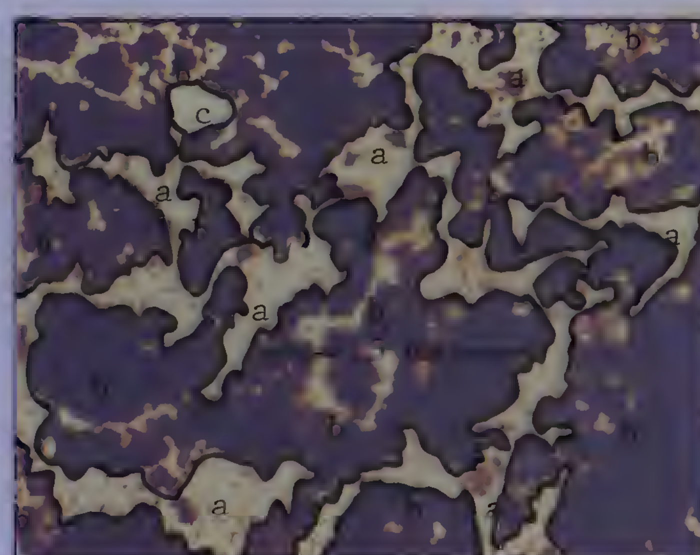
Aeh horizon at site M25 (⟶)



Aeh horizon at site M25 (⟶)

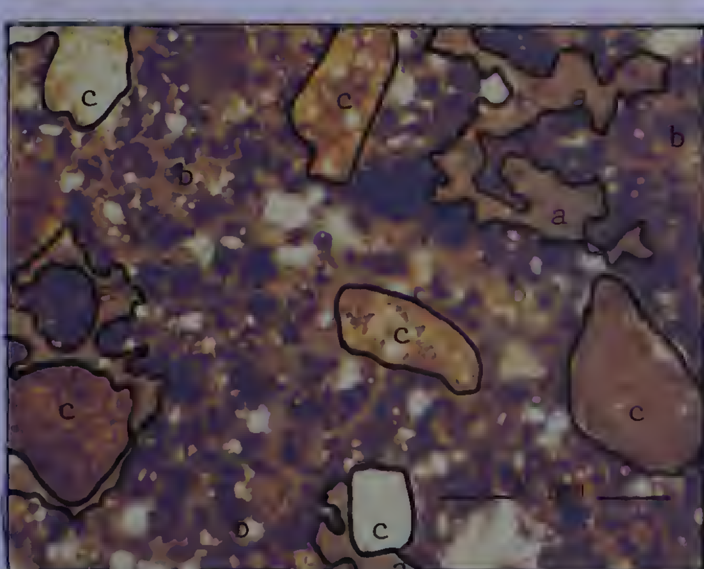


Ahe horizon at site M4 (⟶)

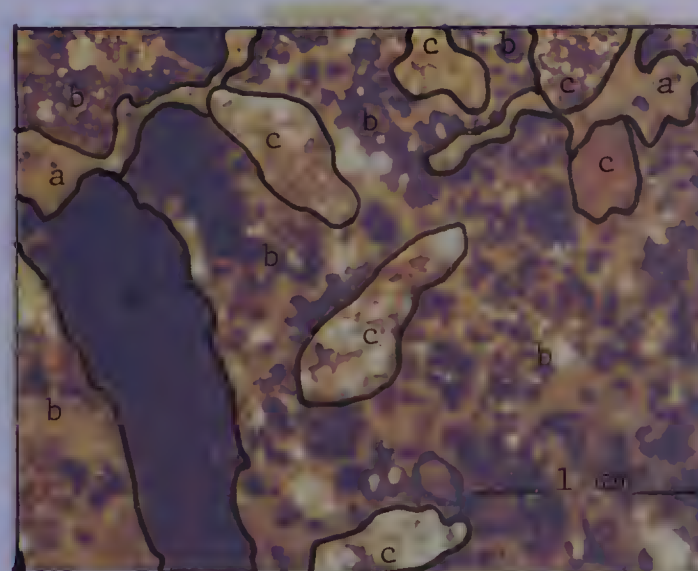


Ah2 horizon at site M6 (⟶)

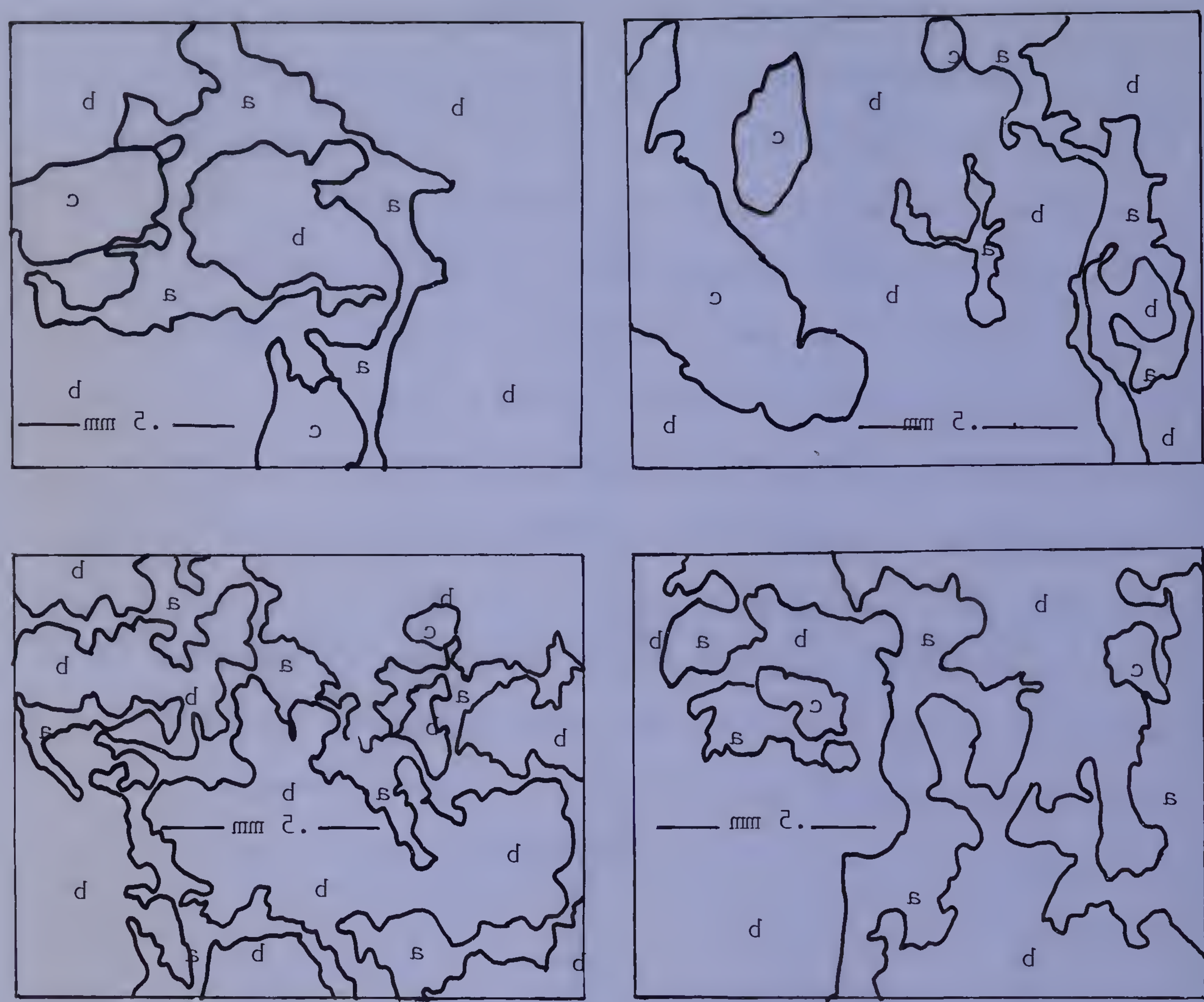
LEGEND: a). voids   b). matrix   c). large minerals



Ah horizon at site M26 (⟶)



Ah horizon at site M27 (⟶)



LEGEND: a). voids b). matrix c). large minerals

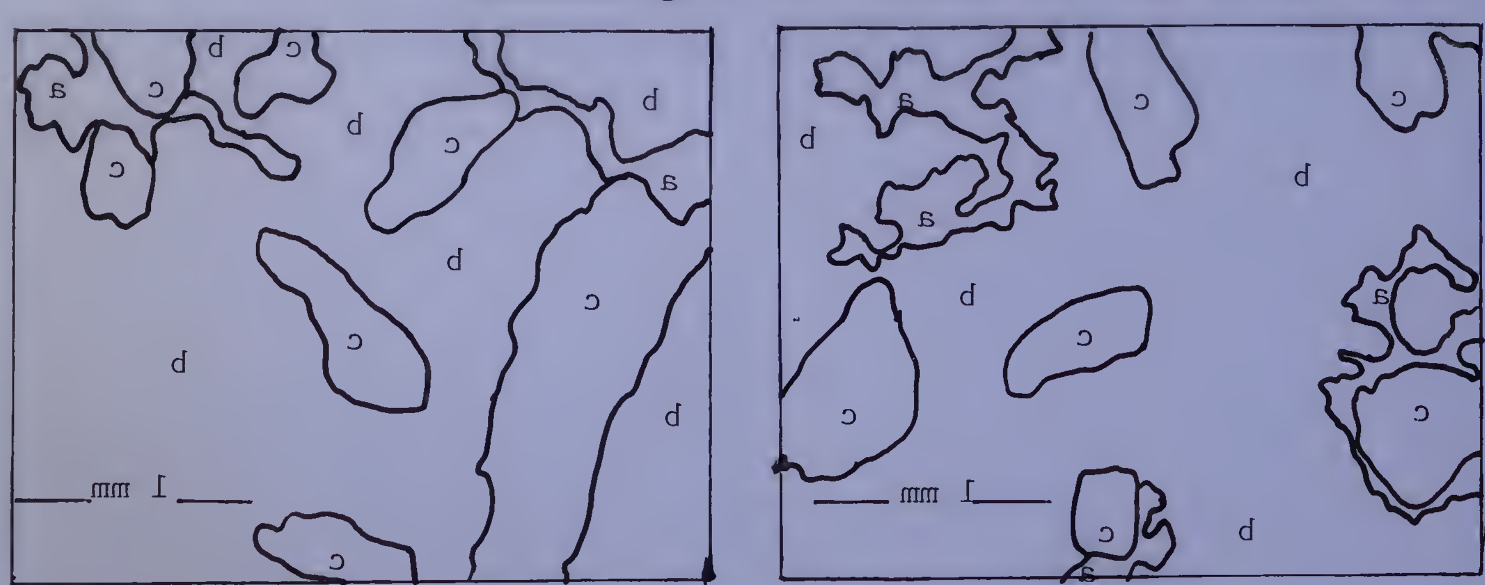
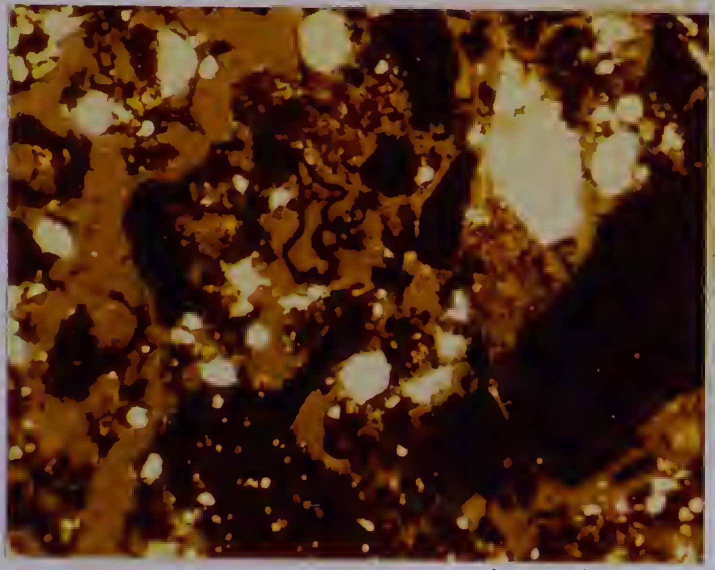
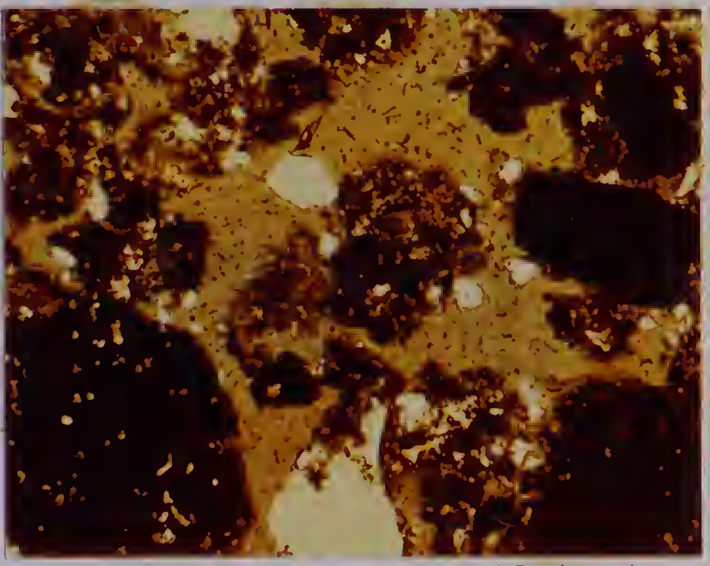


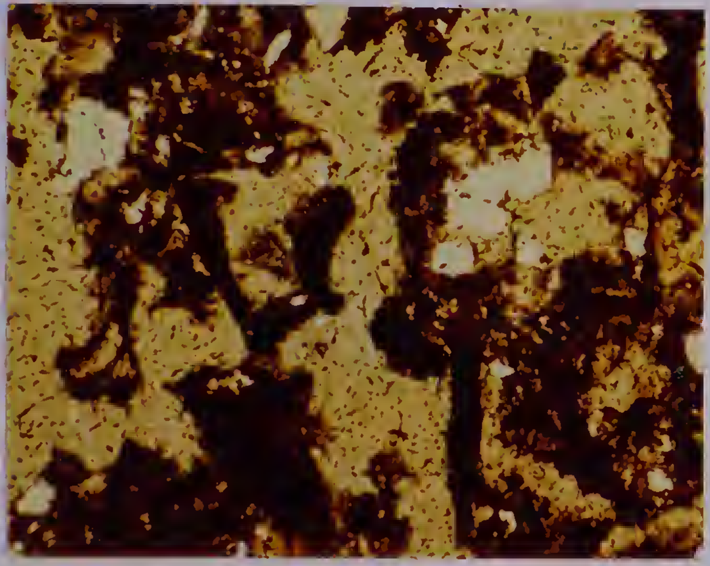
Plate 3. Photomicrographs of thin sections from Ah horizons in Marmot Creek Basin



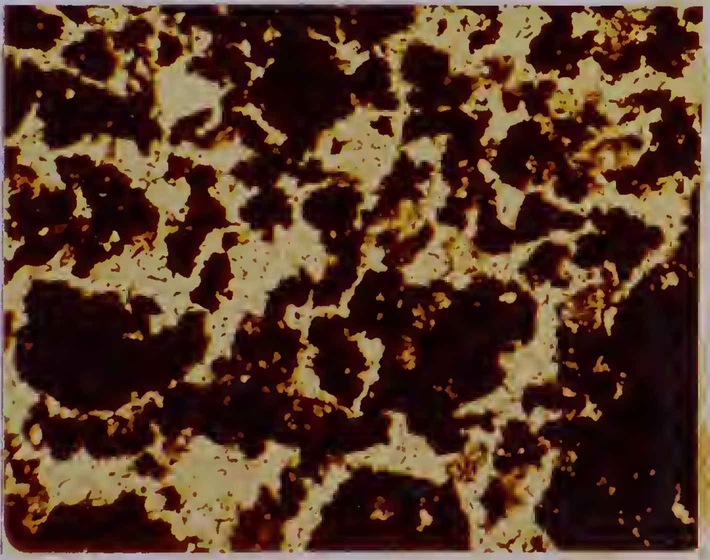
Aeh horizon at site M25 (⟶)



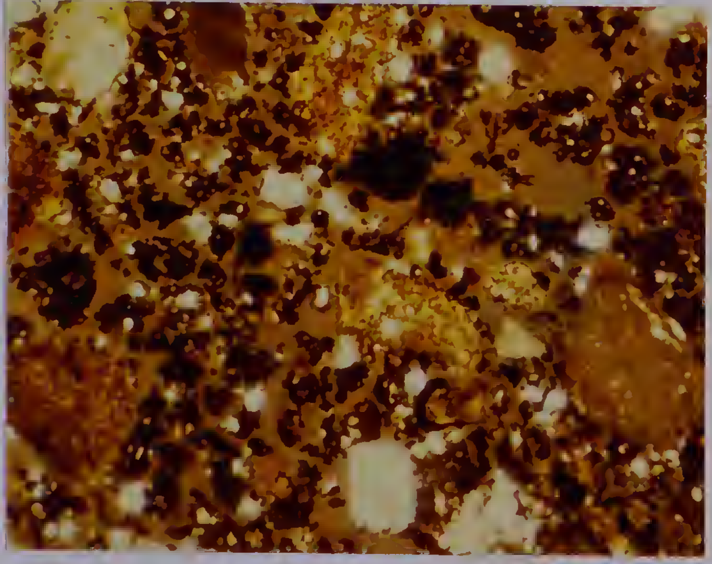
Aeh horizon at site M25 (⟶)



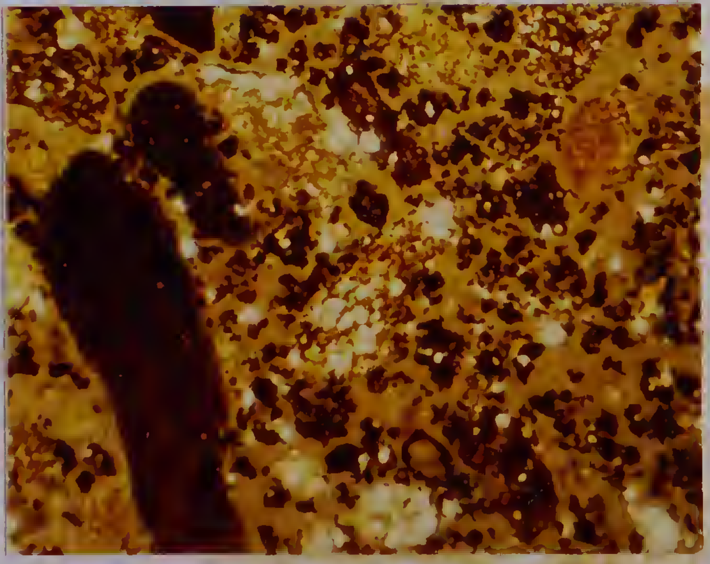
Ahe horizon at site M4 (⟶)



Ah2 horizon at site M6 (⟶)



Ah horizon at site M26 (⟶)



Ah horizon at site M27 (⟶)

DESCRIPTION OF PLATE 3

The prepared thin sections of Ah or Aeh horizons (plate 3) show a micro-structure consisting of individual spherical granulus of plasmic material. In addition, the skeleton grains are loosely bound or unbound to each other and to the plasmic material. The mineral grains show little or no association with the plasmic organic granules. Biological activity is indicated by the ragged edges of the spherical organic granules.

characteristic of the alpine region by including the term "pseudo-alpine" in their classification. A similar terminology has been used for such soils by Duchaufour (1965) and Bliss and Woodwell (1965).

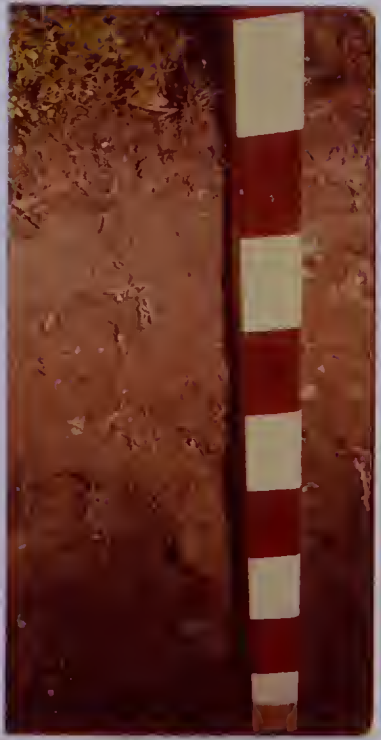
Application of this mode of classification to the basin soils could then be used to indicate the presence of pseudo-alpine Orthic Regosols and pseudo-alpine Alpine Dystric Brunisols. This suggests that there is no proper pedogenic evidence for separating the Alpine Dystric Brunisol into a Class A and a Class B. The use of the term "pseudo-alpine" within the Canadian soil classification scheme (N.S.S.C., 1968) does exemplify the rather unfortunate choice of terminology for the Alpine Dystric Brunisol at the Subgroup level. The ecological connotation of the term "alpine" is very misleading for this soil Subgroup. A more plausible adjective would be "montane" or preferably "dark". If the latter adjective were accepted, then the "Dark" Dystric Brunisol Subgroup would have a connotation somewhat analogous to that of the Dark Gray Luvisol Subgroup.

The sampling sites selected as representative of the soil pattern are sites 5, 6, 9, 19, 21, 25 and 27 (Fig. 6). The soils at these sites, when arranged according to soil zonation sequence are: Brunisolic Gray Luvisol (site 19), Orthic Ferro-Humic Podzol (site 9), Degraded Dystric Brunisol (site 5), Degraded Dystric Brunisol, Class B (site 21), Alpine Dystric Brunisol, Class A (site 25), Alpine Dystric Brunisol, Class B (site 27), and Cumulic Regosol (site 6). The Degraded Dystric Brunisol at site 5 is representative of the average Degraded Dystric Brunisol soil in the basin, while the one at site 21 is typical for the Class B Subgroup.

Plate 4. Photographs of soil profiles from Marmot Creek Basin.

Brunisolic Gray Luvisol (site M19)

Orthic Ferro-Humic Podzol (site M9)



Degraded Dystric Brunisol (site M5)

Degraded Dystric Brunisol (Ranker) (site M21)

Plate 5. Photographs of soil profiles from Marmot Creek Basin.

Alpine Dystric Brunisol (Class A)
(site M25)

Alpine Dystric Brunisol (Class B)
(site M27)

Cumulic Regosol (site M6)

The morphological description and analytical results for the Brunisolic Gray Luvisol soil are presented in Tables II and III. This soil is characterized by high base saturation and neutral pH values. Calcium is the dominant cation on the exchange complex of each horizon in the profile. The B horizons are the most acid horizons of the solum. Organic matter and clay content are higher in the IIBt than in the IIAe horizons. Accumulation of clay in the IIBt horizons is due chiefly to fine clay movement. Similar results have been reported for Gray Luvisols, formerly classified as Gray Wooded soils, developed in Laurentide till deposits (Beke, 1964; Harpstead and Rust, 1964; Pawluk, 1961; St. Arnaud and Whiteside, 1964).

Accumulation of extractable sesquioxides is evident in the solum of this soil. Highest quantities of both aluminum and iron occur in the (Bf) and IIAe horizons. This indicates that in situ release due to weathering of minerals is active and suggests that some translocation as well as transformation of these constituents is taking place in the upper soil horizons. The lower extractable iron and aluminum content in the IIBt horizons as compared to the IIAe and IIC horizons is contrary to expectations (Beke, 1964; St. Arnaud and Whiteside, 1964).

X-ray diffraction patterns of the total clay fraction from the horizons in the solum (Fig. 10) show that illite, vermiculite and kaolinite are the dominant clay minerals throughout the profile. Illite is recognized by its permanent 10 Å reflection while kaolinite is distinguished by its 7 Å reflection which disappears upon heating to 550°C. Vermiculite is distinguished by its expansion to 14 Å upon glycolation

TABLE II. PROFILE DESCRIPTION OF SITE 19 - MARMOT CREEK BASIN

Classification: Brunisolic Gray Luvisol — Elevation: 5595 ft.

Horizon	Depth (cm)	Color Dry	Color Moist	Texture	Structure	Consistence
L - H	2-0					
(Aeh)	0-3	light gray to very pale brown 10 YR 7/2-8/3	grayish brown to light brownish gray 10 YR 5/2-6/2	SiL	weak fine platy	very friable
(Bf)	3-6	brownish yellow 10 YR 6/8	yellowish red 5 YR 4/8	SiL	weak medium granular	friable
IIAe	6-10	light gray to very pale brown 10 YR 7/2-8/3	brown to yellowish brown 1o YR 5/3-5/4	SiL	weak medium platy	friable
IIBt1	10-15	light yellowish brown 10 YR 6/4	dark brown to brown 10 YR 4/3-5/3	CL	strong medium subangular blocky	firm
IIBt2	15-28	yellowish brown 10 YR 5/4	dark yellowish brown 10 YR 4/4	CL	strong medium subangular blocky	firm
IIC	28-62+	dark gray 10 YR 4/1	very dark gray 10 YR 3/1	CL	amorphous	firm

TABLE III. ANALYTICAL CHARACTERISTICS OF THE BRUNISOLIC GRAY LUVISOL AT SITE 19.

Horizon	Depth (cm)	pH	Tot. C %	Tot. N %	C/N Ratio	Exchange Analysis: Exch. Acid. %	Na %	K %	Ca %	Mg %	T.E.C. me/100gms	pH-depend. C.E.C. %	Free Fe_2O_3 Oxalate Fe %	Oxalate Al %	Citrate Fe %	Citrate Al %
L - H	2-0	6.6	15.4	.56	28	18	2	3	69	8	39.2	n.d.	n.d.	n.d.	n.d.	n.d.
(Aeh)	0-3	6.8	2.0	.10	19	8	2	4	82	5	18.5	n.d.	n.d.	n.d.	.35	.03
(Bf)	3-6	6.6	2.1	.22	10	9	2	2	81	6	23.7	n.d.	n.d.	n.d.	.82	.09
IIAe	6-10	6.8	1.2	.06	22	2	1	2	86	10	15.3	n.d.	n.d.	n.d.	.82	.09
IIBt1	10-15	6.6	1.7	.06	29	5	1	3	87	5	5.7	n.d.	n.d.	n.d.	.49	.04
IIBt2	15-28	6.6	1.0	.07	14	5	4	2	75	15	15.1	n.d.	n.d.	n.d.	.60	.06
IIC	28-62+	6.7	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	.62	.06

Horizon	Depth cm	Mechanical Analysis G %	S %	Si %	C %	FC %	Bulk Dens. gm/cc	Spec. Grav.	Poros. %	Moisture Analysis: Sat. Cap. cm.	Sat. Cap. in.	1/3 Bars cm.	1/3 Bars in.	15 Bars cm.	15 Bars in.	A.W.C. cm.	A.W.C. in.	Hygr. Moist. cm.	Hygr. Moist. in.
L - H	2-0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
(Aeh)	0-3	5	21	59	20	7	.87	2.54	65.8	.8	.3	.7	.3	.2	.1	.5	.2	.1	.0
(Bf)	3-6	3	15	59	26	10	n.d.	2.52	65.5	1.0	.4	.8	.3	.3	.1	.5	.2	.1	.0
IIAe	6-10	6	17	61	22	8	n.d.	2.62	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
IIBt1	10-15	9	25	47	28	14	1.04	2.67	61.1	1.5	.6	1.1	.4	.6	.3	.5	.1	.1	.0
IIBt2	15-28	25	24	45	31	15	.94	2.67	64.8	3.5	1.4	2.6	1.0	1.3	.5	1.3	.5	.2	.1
IIC	28-62+	34	26	46	28	11	.82	2.70	69.6	5.5	2.2	4.0	1.6	1.9	.8	2.1	.8	.2	.1

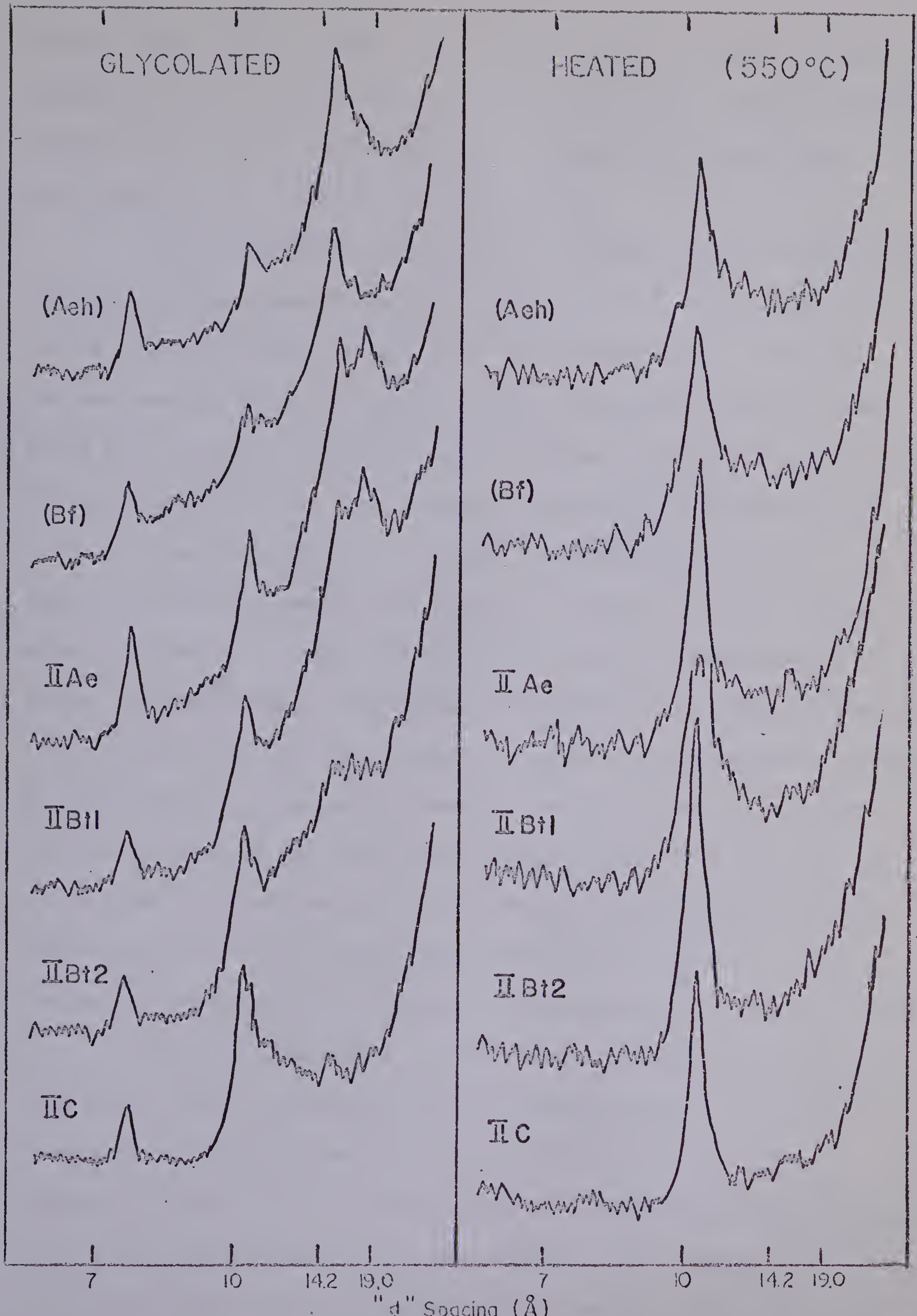


Figure 10. X-ray diffraction patterns of the total clay fraction from the horizons of the Brunisolic Gray Luvisol profile.

(Brown, 1961; Jackson, 1956). K-saturated samples generally did not expand to 14 Å upon glycolation, except in the case of upper B horizons and the (Aeh) horizon samples of this Brunisolic Gray Luvisol soil. The significance of this was not investigated.

Weathering and translocation of colloidal clays in this Brunisolic Gray Luvisol profile is evident from the 14 Å vermiculite and a 15.5 Å mixed-layer clay reflection on the diffractograms. The (Aeh) horizon contains a lesser amount of these constituents than the underlying (Bf) horizon. A similar trend is evident when comparing the diffraction patterns of the IIAe horizon to those of the IIBt horizons.

Comparison of the IIAe, IIBt, and IIC horizons on the basis of extractable sesquioxide content, fine clay content, and clay mineral composition suggests that this part of the solum never did attain full development. The untimely deposition of postglacial surficial material must have slowed down or stopped the developmental process in these horizons. Extractable sesquioxide, total carbon, and total nitrogen contents in the IIAe horizon indicate that this horizon is in the process of transformation to a Bf horizon. Accumulation of these constituents may either result from vertical translocation or from horizontal translocation as a result of lateral movement of ground water.

The parent materials of the Brunisolic Gray Luvisol as identified in the field, are substantiated by analytical and X-ray diffraction results. Horizons developed in the compacted phase of the Kananaskis Valley till are characterized by a specific gravity of about 2.68, a mechanical composition which consists of about 28 per cent clay, and illite, vermiculite and kaolinite clay minerals. The postglacial till-colluvium parent material of the (Aeh) and (Bf) horizons is charac-

terized by a specific gravity of about 2.53, and a total clay content of about 23 per cent, Vermiculite is the dominant clay mineral in these horizons while kaolinite and illite are present in minor amounts.

Characteristics of the Orthic Ferro-Humic Podzol include strong morphological differentiation (Table IV), high exchange acidity and very strongly to strongly acid pH values of the upper solum (Table V). The pH values generally increase with profile depth and reflect the increase in percentage exchangeable calcium, which is the dominant basic cation on the exchange complex. Total carbon, total nitrogen, as well as exchangeable aluminum and iron contents are highest in the upper Bf horizons. The high total exchange capacity of the IIBfh horizon reflects the higher content of colloidal material present. These results compare well with results for similar soils described elsewhere (McKeague and Day, 1966; Clark, McKeague and Nichol, 1966).

Certain anomalies evident in the results appear to reflect stratification of parent materials within this profile. Examples of anomalies include the lower total exchange capacity of the IIIBf1 horizon as compared to the Ae horizon and the range of specific gravity values in the solum. The observed till-colluvium parent material of the Ae horizon is substantiated by the similarity in the X-ray diffraction patterns from this horizon and those from the IVBf2, IVBC, and IVC horizons (Fig. 11). The parent material of the IIBfh horizon appeared to be a mixture of volcanic ash and till colluvium. Microscopic investigations substantiated the presence of the volcanic ash component in this parent material. X-ray diffraction patterns indicate that the characteristics of this parent material are determined chiefly by the till-colluvium component. The observed volcanic ash parent material of

TABLE IV. PROFILE DESCRIPTION OF SITE 9 - MARMOT CREEK BASIN

Classification: Orthic Ferro-Humic Podzol Elevation: 5860 ft.

Horizon	Depth (cm)	Color Dry	Color Moist	Texture	Structure	Consistence
L - H	17 - 0					
Ae	0-4	white 2.5 Y 8/0	gray to light gray 2.5 Y 6/0-7/0	SiL	strong coarse platy	friable
IIBfh	4-8	light yellowish brown 10 YR 6/4	yellowish red 5 YR 4/8	SiL	weak coarse platy	friable
IIIBf1	8-18	very pale brown to yellow 10 YR 7/4-7/6	reddish yellow 7.5 YR 6/8	SiL	strong coarse platy	very friable
IVBf2	18-40	light gray to very pale brown 10 YR 4/2-7/3	pinkish gray 7.5 YR 6/2	SiL	weak medium subangular blocky	friable
IVBC	40-50	light gray 10 YR 7/2	brown to pale brown 10 YR 5/3-6/3	SiL	amorphous	friable
IVC	50-65+	light gray 10 YR 7/2	dark brown to brown 10 YR 4/3	SiL	amorphous	friable

TABLE V. ANALYTICAL CHARACTERISTICS OF THE ORTHIC FERRO-HUMIC PODZOL AT SITE 9

Horizon	Depth	pH	Tot. C	Tot. N	C/N Ratio	Exch. Acid.	Na	K	Ca	Mg	T.E.C.	pH-Depend. C.E.C.	Free Fe_2O_3 Oxalate Fe	Oxalate Al	Citrate Fe	Citrate Al
	cm		%	%		%	%	%	%	%	me/100 gms	%	%	%	%	%
L - H	17-0	4.2	42.6	.71	60	37	1	7	44	12	89.2	n.d.	.03	.03	n.d.	n.d.
Ae	0-4	4.3	2.6	.07	37	61	1	2	25	10	15.3	n.d.	.04	.04	.28	.05
IIBfh	4-8	5.4	2.8	.13	21	54	1	5	33	7	25.9	n.d.	.42	.83	1.01	.16
IIIBf1	8-18	6.1	1.7	.07	24	43	2	7	43	5	14.5	n.d.	.24	1.08	.44	.12
IVBf2	18-40	5.9	1.3	n.d.	n.d.	13	2	3	76	6	9.4	n.d.	.16	.03	.95	.11
IVBC	40-50	6.0	2.0	n.d.	n.d.	11	8	2	68	12	10.4	n.d.	.09	.02	1.06	.13
IVC	50-65+	5.8	1.2	n.d.	n.d.	10	2	2	72	13	10.7	n.d.	.10	.03	.42	.05

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Spec. Grav.	Poros.	Moisture Analysis Sat. Cap.		1/3 Bars		15 Bars		A.W.C.		Hygr.Moist.	
	cm	%	%	%	%	%	gm/cc		%	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.
L - H	17-0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Ae	0-4	2	20	61	19	7	.69	2.48	72.2	3.6	1.4	2.8	1.1	2.3	.9	.6	.2	.0	.0
IIBfh	4-8	6	20	55	25	9	.69	2.39	71.1	1.8	.7	.7	.3	.2	.1	.6	.2	.0	.0
IIIBf1	8-18	0	21	69	10	5	1.26	2.34	46.2	4.7	1.8	5.3	2.0	1.4	.5	3.9	1.5	.4	.1
IVBf2	18-40	9	23	59	18	5	1.28	2.68	52.2	11.9	4.7	5.9	2.3	1.3	.5	4.6	1.8	.3	.1
IVBC	40-50	4	18	64	18	5	1.49	2.63	43.3	4.3	1.7	3.5	1.3	.7	.2	2.7	1.1	.1	.0
IVC	50-65+	20	21	58	21	9	1.46	2.62	44.3	15.5	6.1	6.2	2.4	3.2	1.2	3.2	1.2	.6	.2

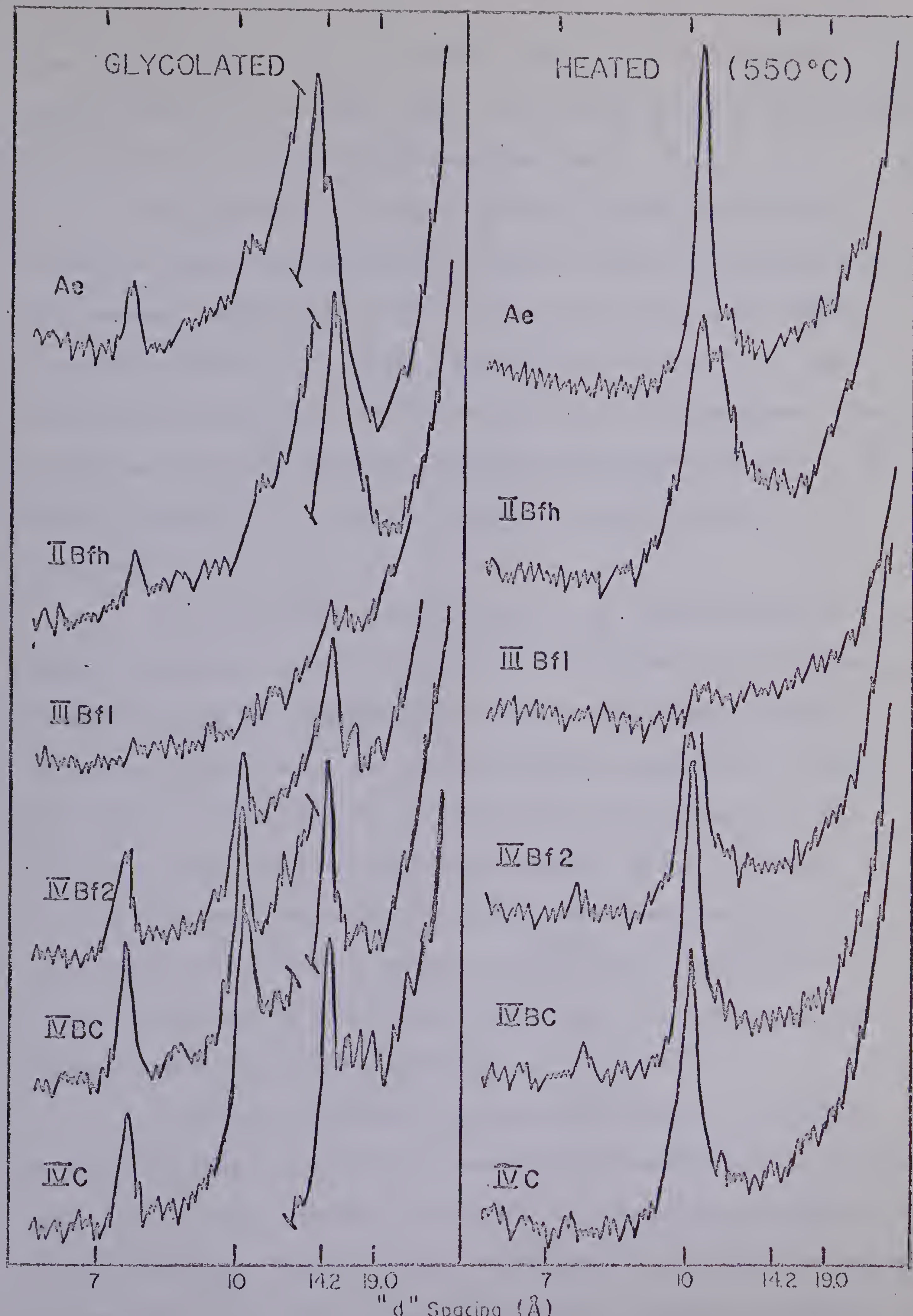


Figure 11. X-ray diffraction patterns of the total clay fraction from the horizons of the Orthic Ferro-Humic Podzol profile.

the IIIBf1 horizon and the Kananaskis Valley till, non-compacted phase, parent material of the IVBf2, IVBC, and IVC horizons have characteristics as outlined previously for these deposits.

Non-conformity of parent materials in the solum and low effective annual precipitation in the basin prompted investigation of the pedogenic significance of the volcanic ash layer in the Orthic Ferro-Humic Podzol soil. Three supposedly unaltered volcanic ash C horizons were included in this study for reasons of comparison. These C horizons were from the Peaty Carbonated Rego Gleysol at site 1, the Terric Fibrisol at site 31, and the Cumulic Regosol at site 36, respectively.

The nature of the volcanic ash in the IIIBf1 horizon of the Orthic Ferro-Humic Podzol is similar to that in the three C horizons. This is evident from source analysis (Smith and Westgate, 1969), presence of glass shards and pumice fragments, particle size distribution (Fig. 8, p. 58; Fig. 9, p. 59), thin section (Plate 1, p. 52; Plate 2, p. 66), and X-ray diffraction analysis (Fig. 12 and 13). Variations amongst these supposedly-unaltered C horizons in X-ray diffraction pattern and in specific gravity values (Appendix I-B) imply that the ash in these horizons has been subjected to pedogenic development since time of deposition.

Pedogenic development in the IIIBf1 horizon of the Orthic Ferro-Humic Podzol consists of accumulation of oxalate-soluble aluminum and iron and citrate-soluble iron (Table V) when compared to the volcanic ash C horizons (Appendix I-B). The distinct accumulation of oxalate-extractable sesquioxides in the IIIBf1 horizon conforms to Podzol B

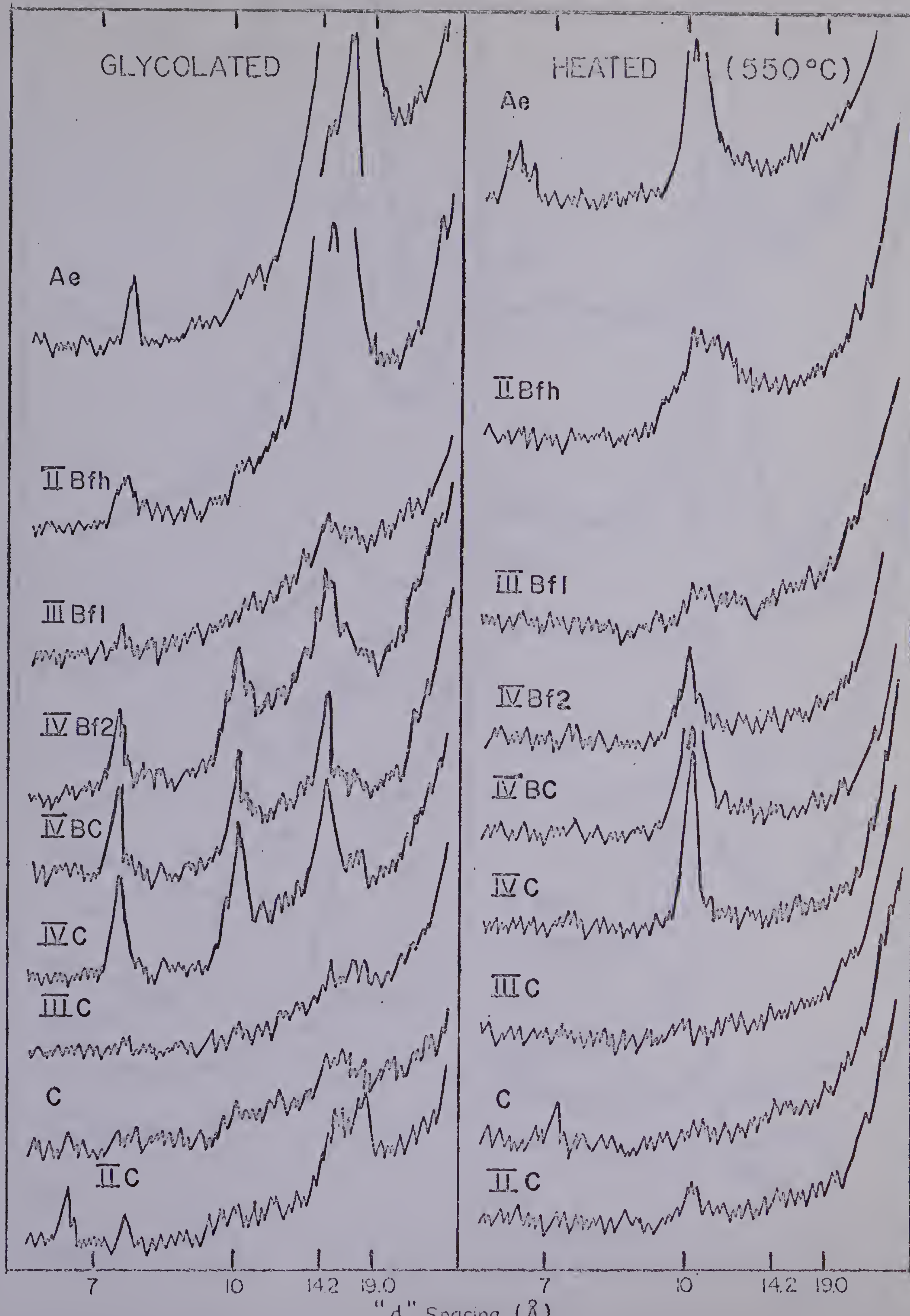


Figure 12. X-ray diffraction patterns of the coarse (2- .2μ) clay fraction from the selected volcanic ash C horizons and the horizons of the Orthic Ferro-Humic Podzol.

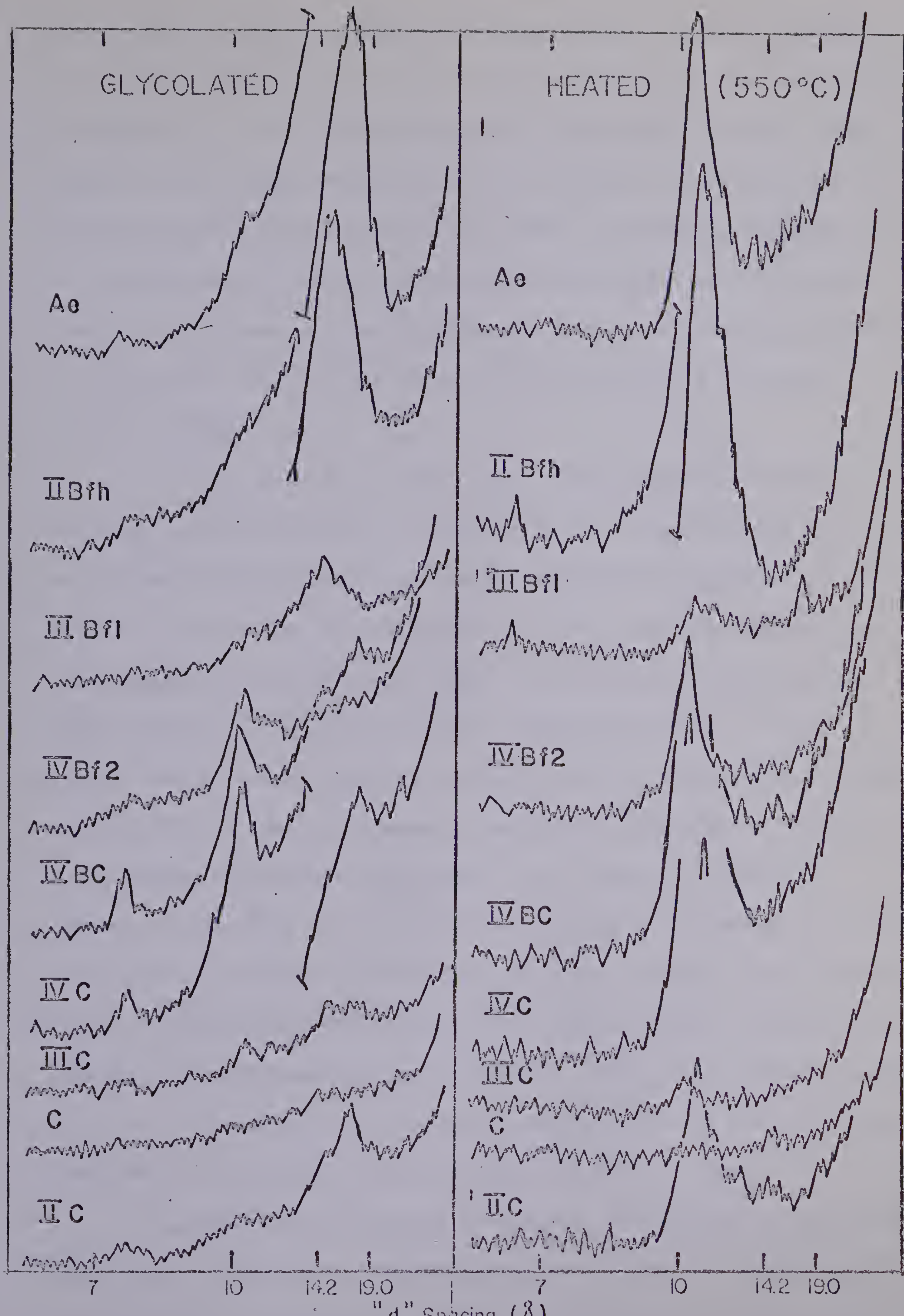


Figure 13. X-ray diffraction patterns of the fine (< .2 μ) clay fraction from the selected volcanic ash C horizons and the horizons of the Orthic Ferro-Humic Podzol.

horizon characteristics (McKeague and Day, 1966). However, accumulation of these constituents is not readily evident from the results for total (Table VI) and citrate-extractable sesquioxides content. This suggests that in situ weathering of heavy mineral constituents of the volcanic ash (Westgate and Dreimanis, 1967) is largely responsible for the accumulation of oxalate-extractable sesquioxides in this horizon. Since the accretion of these constituents cannot be attributed primarily to illuviation, this horizon cannot be classified as a Bf horizon (N.S.S.C., 1968).

The non-podzolic nature of the IIIBf1 horizon is substantiated by the X-ray diffraction results (Figs. 12 and 13) and by the results for allophanic material content (Table VI). There is no evidence of accumulation of allophanic material in the clay fraction or translocation of clay minerals (Figs. 12 and 13) when comparing the IIIBf1 horizon to the ash C horizons. The banded fabric of all volcanic ash horizons (Plate 1, p. 52; Plate 2, p. 66) provides further evidence for the limited pedogenic development of the IIIBf1 horizon in the Orthic Ferro-Humic Podzol soil. This type of fabric is apparently the result of the mode of deposition of the material, rather than eluviation (Dumanski and St. Arnaud, 1966). These results indicate that the morphological expression of the IIIBf1 horizon reflects the lithology of the Mazama ash parent material rather than podzolic development. As a consequence, this Orthic Ferro-Humic Podzol soil should be classified as a Degraded Dystric Brunisol (N.S.S.C., 1968).

Limited effective depth of podzolic development in this profile is also evident from the properties of the horizons underlying the IIIBf1 horizon. The properties of the IVBf2 horizon vary from those of

TABLE VI. ALLOPHANIC MATERIAL CONCENTRATIONS IN THE COARSE (2-0.2) AND FINE (0.2) CLAY FRACTIONS AND TOTAL IRON AND ALUMINUM CONTENT OF THE FINE CLAY FRACTION.

Profile		Horizon	% SiO_2		% Al_2O_3		SiO_2/Al_2O_3 ratio		% (SiO_2+ Al_2O_3)		% Amorphous		Total R_2O_3 in Fine Clay	
No.	Classification		cc'	fc+	cc	fc	cc	fc	cc	fc	cc	fc	Al %	Fe %
9	Orthic Ferro-Humic Podzol	Ae	14.5	6.5	1.6	1.6	9.1	4.1	16.1	8.1	17.9	9.0	3.02	1.12
		IIBfh	19.8	18.0	4.6	7.1	4.3	2.5	24.4	25.1	27.1	27.9	9.02	3.78
		IIIBf1	31.4	11.6	7.3	4.8	4.3	2.4	38.7	16.4	43.0	18.2	8.57	3.01
		IVBf2	11.3	n.d.	2.9	n.d.	3.3	n.d.	14.2	n.d.	15.8	n.d.	4.80	2.72
		IVBC	5.9	8.3	1.3	2.6	4.5	3.2	7.2	10.9	8.0	12.1	3.42	2.58
		IVC	4.7	8.2	1.2	2.6	3.9	3.2	5.9	10.8	6.6	12.0	4.58	2.95
1	Peaty Carb. Rego Gleysol	IIIC	35.1	21.5	7.1	7.9	4.9	2.7	42.2	29.4	46.9	32.6	7.76	2.39
31	Terric Fibrisol	C	27.5	20.6	7.4	7.3	3.7	2.8	34.9	27.8	38.8	30.9	9.13	2.64
36	Cumulic Regosol	IIC	28.0	21.0	6.5	6.9	4.3	3.0	34.5	27.9	38.3	31.0	7.89	2.34

' coarse clay

+ fine clay

the IVBC and IVC horizons primarily by a slight increase in allophanic material content and by the slight change in the clay mineral composition. These pedogenic differences are likely due to soil development prior to ash deposition rather than to recent soil formation. The Mount Mazama eruption occurred over 3,000 years after the dwindling of the Late Wisconsin-Cordilleran Complex, which was placed by Heusser (1956) at about 10,000 years B.P. This should have been sufficient time for the development of a Eutric Brunisol soil, which conforms to the properties of the profile from the IVBf2 horizon downward. Accretion of allophanic material in the clay fraction of the IVBf2 horizon may then be ascribed to further development and depth extension of the current profile.

The morphological description and analytical results for the Degraded Dystric Brunisol profile are shown in Tables VII and VIII, respectively. This particular soil is considered to be representative of the average Degraded Dystric Brunisol in the basin. It is characterized by very strongly acid pH values and high exchange acidity. The L-H horizon is the most acid and contains the highest percentage of exchangeable acidity in the solum. Exchangeable acidity generally decreases and pH values increase with depth in the profile. Calcium is generally the dominant basic cation on the exchange complex of the horizons. Accumulation of extractable sesquioxides is evident but is less pronounced than in podzolic soils (McKeague and Day, 1966; Schwertmann, 1964). Eluviation of colloidal clay is limited in this soil, although the diffraction patterns of the horizons (Fig. 14) show that some vermiculite clay has accumulated in the Bfhj horizon. Similar results have been reported by Pawluk and Lindsay (1964) for a Degraded

TABLE VII. PROFILE DESCRIPTION OF SITE 5 - MARMOT CREEK BASIN

Classification: Degraded Dystric Brunisol Elevation: 6770 ft.

Horizon	Depth (cm)	Color Dry	Color Moist	Texture	Structure	Consistence
L - H	4-0				matted organic material	
Ae	0-10	light gray 10 YR 7/1	gray 10 YR 5/1-6/1	SiL	strong coarse platy	friable
Bfhj	10-17	pink 10 YR 7/3	reddish brown 5 YR 4/3-4/4	CL	strong medium granular	friable
Bfj	17-28	light yellowish brown 10 YR 6/4	brown 7.5 YR 4/2-5/2	SiL	strong medium granular	friable
BC	28-42	grayish brown to brown 10 YR 5/2-5/3	very dark grayish brown 10 YR 3/2	SiL	weak medium granular	friable
C	42-60+	dark gray to dark grayish brown 10 YR 4/1-4/2	very dark brown 10 YR 2/2	SiCL	amorphous	firm

TABLE VIII. ANALYTICAL CHARACTERISTICS OF THE DEGRADED DYSTRIC BRUNISOL AT SITE 5

Horizon	Depth	pH	Tot. C	Tot. N	C/N Ratio	Exch. Acid.	Exchange Analysis Na	K	Ca	Mg	T.E.C.	pH-Depend. C.E.C.	Free Fe_2O_3 Oxalate Fe	Oxalate Al	Citrate Fe	Citrate Al
	cm		%	%		%	%	%	%	%	me/100 gms	%	%	%	%	%
L - H	4-0	4.3	28.7	.81	35	68	0	1	25	6	64.9	n.d.	.05	.00	n.d.	n.d.
Ae	0-10	4.5	3.9	.12	32	67	1	1	30	1	15.1	93	.04	.00	.30	.02
Bfhj	10-17	4.9	2.9	.10	29	31	1	1	30	37	20.4	92	.27	.11	.57	.05
Bfj	17-28	5.0	2.9	.09	33	56	1	2	32	9	12.7	94	.20	.00	.44	.04
BC	28-42	5.0	2.7	n.d.	n.d.	53	1	3	38	5	12.1	85	.16	.01	.39	.04
C	42-60+	5.7	4.3	n.d.	n.d.	15	1	1	74	9	16.9	100	.06	.00	.66	.06

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Spec. Grav.	Poros.	Moisture Analysis Sat. Cap.	Sat. Cap.	1/3 Bars	1/3 Bars	15 Bars	15 Bars	A.W.C.	A.W.C.	Hygr.Moist.	Hygr.Moist.
	cm.	%	%	%	%	%	gm/cc		%	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.
L - H	4-0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Ae	0-10	16	23	55	22	9	1.01	2.40	57.9	3.4	1.3	2.0	.7	.7	.2	1.8	.7	.1	.0
Bfhj	10-17	22	21	49	30	11	1.07	2.53	57.7	3.6	1.4	2.2	.8	1.2	.4	1.0	.4	.2	.0
Bfj	17-28	26	25	52	23	8	.94	2.50	62.4	2.7	1.0	1.8	.7	.8	.3	1.1	.4	.1	.0
BC	28-42	28	27	52	21	7	1.06	2.54	58.3	5.3	2.1	3.3	1.3	1.5	.6	1.7	.7	.2	.1
C	42-60+	36	20	53	27	11	1.39	2.53	45.1	12.1	4.7	4.7	1.8	4.5	1.7	2.9	1.1	.7	.2

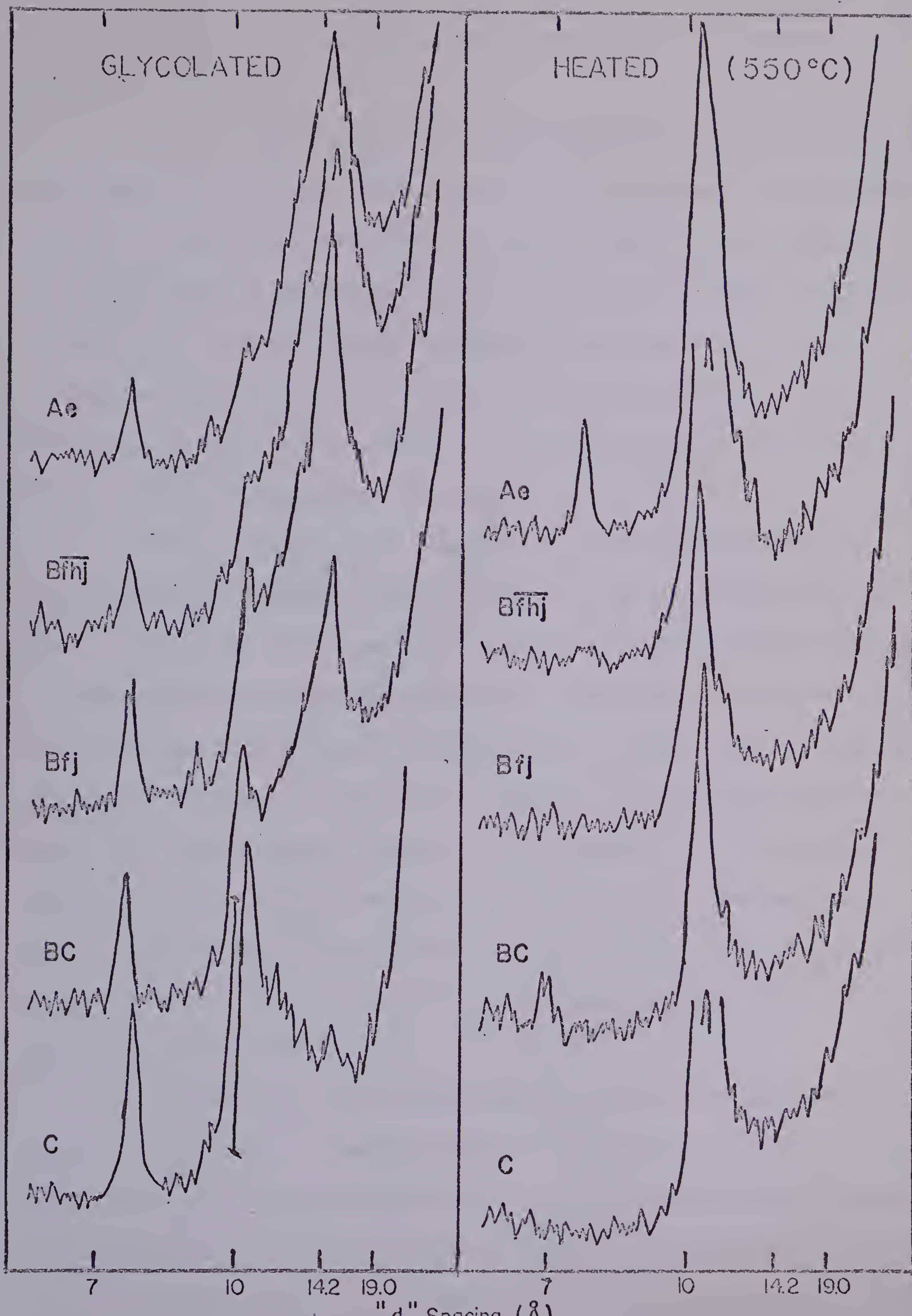


Figure 14. X-ray diffraction patterns of the total clay fraction from the horizons of the Degraded Dystric Brunisol profile.

Acid Brown Wooded soil (N.S.S.C., 1963) developed in Laurentide drift in northern Alberta.

The characteristics of this Degraded Dystric Brunisol soil meet most of the criteria delineated for Sols podzoliques by Duchaufour (1965) in the French classification system. The criteria in common are an ABC type of profile, mor humus, a distinct but weakly coloured Ae horizon, a B horizon having reddish or yellowish colours, and pH values in the order of 4 to 6. The Degraded Dystric Brunisol does not meet the criterion of the presence of a thin Ah horizon as outlined for the modal Sol podzolique (Duchaufour, 1965).

The morphological and analytical characteristics for the Degraded Dystric Brunisol (Class B) profile (Tables IX and X) include poor morphological development and relatively undifferentiated analytical characteristics throughout the solum. The upper part of the solum has an extremely to strongly acid pH; the Ae horizon being the most acid horizon in the solum. The pH values generally increase with profile depth and show an abrupt increase at the interface of the two parent materials from which this soil developed. Calcium is the dominant basic cation on the exchange complex of all horizons. The Aej horizon has the highest total carbon and total nitrogen content of the mineral horizons in the profile.

Extractable sesquioxides generally decrease with increase in depth of the profile. However, eluviation of colloidal clay is evident from the X-ray diffraction patterns (Fig. 15). Degradation of clay in the Aej horizon is indicated by the presence of the continuous 10 to 14 Å reflection, which is representative of interstratified 10 and 14 Å clay minerals. Illuviation of clay into the Bfj horizon is evident

TABLE IX. PROFILE DESCRIPTION OF SITE 21 - MARMOT CREEK BASIN

Classification: Degraded Dystric Brunisol (Class B) Elevation: 6,600 ft.

Horizon	Depth (cm)	Color Dry	Color Moist	Texture	Structure	Consistence
L - H	8-0					
Aej	0-8	light brownish gray to light gray 10 YR 6/2-7/2	grayish brown 10 YR 5/2	L	moderate, medium platy	very friable
Bfj	8-33	light brownish gray 10 YR 6/2	reddish brown 5 YR 4/3	L	coarse platy to strong granular	very friable
BC	33-57	light brownish gray 10 YR 6/2	dark reddish gray 5 YR 4/2	L-SiL	mod. medium granular	very friable
IIACb	57-63	gray to grayish brown 10 YR 5/1-5/2	very dark gray 10 YR 3/1	SL	weak medium granular	very friable
IIC	63-90+	brownish gray 10 YR 6/2	dark gray 10 YR 4/1	L	amorphous	very friable

TABLE X. ANALYTICAL CHARACTERISTICS OF THE DEGRADED DYSTRIC BRUNISOL (CLASS B) AT SITE 21

Horizon	Depth	pH	Tot. C	Tot. N	C/N Ratio	Exchange Analysis: Exch. Acid.	Na	K	Ca	Mg	T.E.C.	pH-Depend. C.E.C.	Free Fe_2O_3: Oxalate Fe	Oxalate Al	Citrate Fe	Citrate Al
	cm		%	%		%	%	%	%	%	me/100gms	%	%	%	%	%
L - H	8-0	4.4	32.4	.76	43	n.d.	n.d.	n.d.	n.d.	n.d.	59.4	n.d.	n.d.	n.d.	n.d.	n.d.
Aej	0-8	4.3	5.1	.18	28	66	1	3	25	5	18.8	97	.05	.04	.41	.04
Bfj	8-33	5.2	2.5	.12	16	56	1	2	34	8	13.7	97	.06	.06	.30	.03
BC	33-57	5.0	2.3	.10	22	n.d.	n.d.	n.d.	n.d.	n.d.	15.0	97	.04	.04	.27	.03
IIACb	57-63	6.0	5.7	.10	56	24	1	1	70	5	14.4	100	n.d.	n.d.	.16	.02
IIC	63-90+	6.2	3.5	n.d.	n.d.	11	0	1	80	8	12.2	n.d.	n.d.	n.d.	.16	.02

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Spec. Grav.	Poros.	Moisture Analysis: Sat.	Cap.	1/3 Bars		15 Bars		A.W.C.		Hygr. Moist.	
		%	%	%	%	%	gm/cc		%	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.
L - H	8-0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Aej	0-8	2	32	46	22	9	n.d.	2.42	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Bfj	8-33	8	35	48	17	7	n.d.	2.48	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
BC	33-57	10	35	50	15	7	n.d.	2.51	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
IIACb	57-63	28	54	37	9	7	n.d.	2.52	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
IIC	63-90+	26	42	48	10	5	n.d.	2.59	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

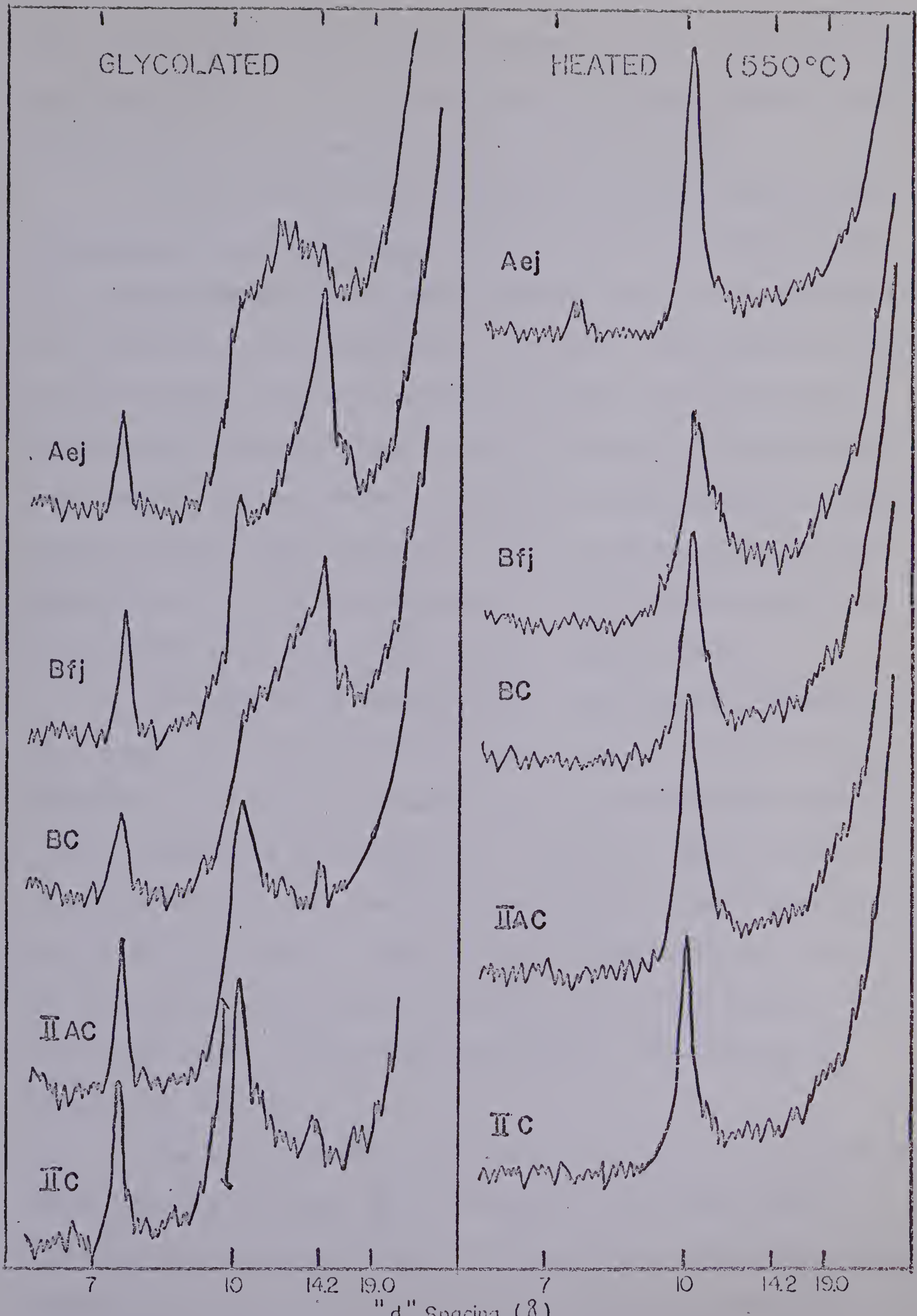


Figure 15. X-ray diffraction patterns of the total clay fraction from the horizons of the Degraded Dystric Brunisol (Class B) profile.

from the 14 Å vermiculite peak when compared to that of the other horizons in the solum. Similar characteristics have been reported by Carbiener (1963) for Cryptopodzolic Ranker soils of France.

The morphological description and analytical result for the Alpine Dystric Brunisol (Class A) soil are presented in Tables XI and XII. Characteristics of the profile include a poorly expressed eluviated horizon and a strongly coloured B horizon. The solum has strongly to very strongly acid pH values which is lowest in the Aeh horizon. Exchangeable acidity is highest in the Bfj horizon. Total carbon and total nitrogen content decrease progressively with increase in profile depth. The high amount of organic matter and the moder-type of soil humus (Plate 3, p. 68) are characteristic of well-drained soils developed under larch (Larix spp.) forests (Tikhonov, 1963).

Accumulation of extractable iron and aluminum is evident in this solum. The increase of these constituents in the Bfj horizon as compared to the Aeh horizon suggests that translocation and transformation of sesquioxides are taking place. X-ray diffraction patterns of the total clay fractions show a distinct increase of 14 Å vermiculite clay in the Bfj horizon of this profile while degradation of clay in the Aeh horizon appears minimal (Fig. 16). This, together with other analytical results suggests that the process of podzolization is operative in this soil.

The characteristics of this profile are generally similar to those described by Tedrow, et al. (1958) for Arctic Brown soils in Alaska developed under coniferous forest vegetation. The Alpine Dystric Brunisol soil also meets most of the criteria delineated for Brown

TABLE XI. PROFILE DESCRIPTION OF SITE 25 - MARMOT CREEK BASIN

Classification: Alpine Dystric Brunisol (Class A) Elevation: 7260 ft.

Horizon	Depth (cm)	Color Dry	Color Moist	Texture	Structure	Consistence
L - H	3-0					
Aeh	0-8	grayish brown 10 YR 5/2	v. dark grayish brown 10 YR 3/2	L	moderate fine granular	very friable
Bfj	8-18	yellowish brown to light yellowish brown 10 YR 5/4-6/4	dark reddish brown 5 YR 3/3	L	moderate medium granular	very friable
IIBC	18-42	light yellowish brown 10 YR 6/4	brown 10 YR 5/3	L	single grained	very friable
IIC	42-70+	light brownish gray 10 YR 6/2	very dark grayish brown 10 YR 3/2	L	single grained	very friable

TABLE XII. ANALYTICAL CHARACTERISTICS OF THE ALPINE DYSTRIC BRUNISOL (CLASS A) AT SITE 25

Horizon	Depth	pH	Tot. C	Tot. N	C/N Ratio	Exchange Analysis: Exch. Acid.	Na	K	Ca	Mg	T.E.C.	pH-Depend. C.E.C.	Free Fe_2O_3: Oxalate Fe	Oxalate Al	Citrate Fe	Citrate Al
	cm		%	%		%	%	%	%	%	me/100gms	%	%	%	%	%
L - H	3-0	5.4	21.2	.94	23	28	0	4	65	4	44.7	n.d.	n.d.	n.d.	n.d.	n.d.
Aeh	0-8	4.7	4.9	.25	20	57	1	2	37	4	25.9	89	.08	.08	.28	.03
Bfj	8-18	4.9	3.8	.16	24	64	1	1	29	6	24.3	88	.24	.14	.77	.12
IIBC	18-42	5.0	2.2	.08	n.d.	47	0	1	42	10	15.6	89	.10	.08	.65	.08
IIC	42-70+	5.5	1.8	n.d.	n.d.	29	1	1	57	12	12.8	99	.07	.07	.55	.06

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Spec. Grav.	Poros.	Moisture Analysis: Sat.	Cap.	1/3 Bars		15 Bars		A.W.C.		Hygr.Moist.	
	cm.	%	%	%	%	%	gm/cc		%	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.
L - H	3-0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Aeh	0-8	15	26	49	25	9	.99	2.45	59.6	2.0	.8	1.6	.6	.8	.3	.8	.3	.1	.0
Bfj	8-18	8	29	49	22	7	1.33	2.52	47.2	3.9	1.5	2.6	1.0	1.3	.5	1.3	.6	.3	.1
IIBC	18-42	44	37	46	17	5	1.56	2.63	40.7	6.4	2.5	5.1	2.0	2.5	1.0	2.6	1.0	.5	.2
IIC	42-70+	34	40	46	14	5	1.38	2.61	47.1	6.4	2.5	4.8	1.9	2.2	.9	2.6	1.0	.4	.1

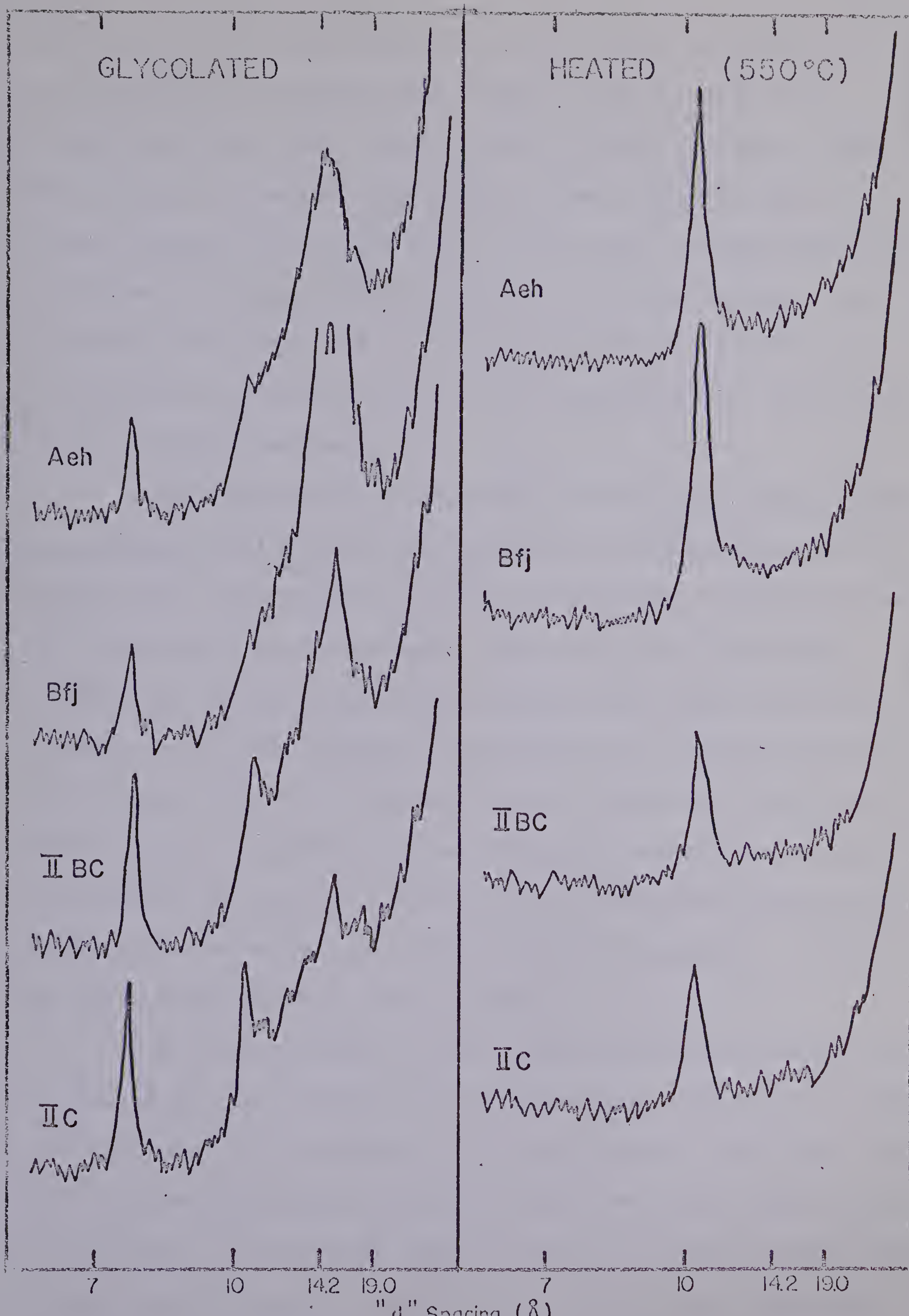


Figure 16. X-ray diffraction patterns of the total clay fraction from the horizons of the Alpine Dystric Brunisol (Class A) profile.

Podzolic soils in Great Britain (Ball, 1966) and for Sols ochres ou bruns podzoliques developed under deciduous forest in continental Europe (Duchaufour, 1965; Kubiena, 1953; Valenti and Sanesi, 1967). The criteria in common with the Ochric or Brown Podzolic soils of Europe include an ABC type of profile, moder humus, a weakly developed Ae horizon, a strongly coloured B horizon having poor structure, and pH values in the order of 4 to 5. This Alpine Dystric Brunisol does not have the very low base saturation as reported for its counterparts in Italy (Valenti and Sanesi, 1967).

The morphological characteristics of the Alpine Dystric Brunisol (Class B) profile include distinct horizon differentiation and the presence of a well-developed Ah horizon (Table XIII). Analytical results generally reflect the morphological characteristics of this solum (Table XIV). The Ah horizon has a very high total carbon and total nitrogen content when compared to the Bm horizon. Photomicrographs of thin sections (Plate 3, p. 68) show that the soil humus present is of the moder type. The Ah horizon has the highest exchangeable acidity and the lowest pH in the solum. Accumulation of oxalate-extractable sesquioxides in the Bm horizon is not evident and the accumulation of citrate-extractable sesquioxides is very limited.

The characteristics of this profile are generally comparable to that of the Alpine Dystric Brunisol (Class A). These profiles differ from each other in the nature of the A and B horizons. The Class B soil has a distinct Ah horizon while that of the Class A soil shows evidence of eluviation. A chernozemic type of B horizon is present in the Class B soil versus a brunisolic B in the Class A soil. These differences likely reflect the nature of the vegetation occurring at these locations.

TABLE XIII. PROFILE DESCRIPTION OF SITE 27 - MARMOT CREEK BASIN

Classification: Alpine Dystric Brunisol (Class B) Elevation: 7410 ft.

Horizon	Depth (cm)	Color Dry	Color Moist	Texture	Structure	Consistence
L-F	5-0				root mat	
Ah	0-12	very dark gray to grayish brown 10 YR 3/1-3/2	very dark brown to gray 10 YR 2/2-3/1	L-CL	strong medium granular	friable
Bm	12-25	brown to dark brown 10 YR 4/3	dark yellowish brown 10 YR 3/4	L	weak medium subangular blocky	very friable
C	25-40	dark grayish brown 10 YR 4/2	very dark brown 10 YR 2/2	L	single grained	very friable
Rock	40+					

TABLE XIV. ANALYTICAL CHARACTERISTICS OF THE ALPINE DYSTRIC BRUNISOL (CLASS B) AT SITE 27

Horizon	Depth	pH	Tot. C	Tot. N	C/N Ratio	Exch. Acid.	Na	K	Ca	Mg	T.E.C.	pH-Depend. C.E.C.	Free Fe_2O_3 Oxalate Fe	Oxalate Al	Citrate Fe	Citrate Al
	cm		%	%		%	%	%	%	%	me/100gms	%	%	%	%	%
L - F	5-0	5.9	22.2	1.04	22	20	2	2	70	6	59.4	n.d.	n.d.	n.d.	n.d.	n.d.
Ah	0-12	5.2	9.6	.53	18	41	1	1	50	7	21.7	n.d.	.09	.09	1.02	.13
Bm	12-25	5.5	3.8	.12	31	25	0	1	67	7	15.4	n.d.	.06	.06	1.16	.13
C	25-40	5.8	n.d.	n.d.	n.d.	24	1	2	69	4	16.6	n.d.	.10	.09	.94	.11
Rock	40+															

Exchange Analysis columns: Exch. Acid., Na, K, Ca, Mg, T.E.C.

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Spec. Grav.	Poros.	Sat. Cap. cm.	Sat. Cap. in.	1/3 Bars cm.	1/3 Bars in.	15 Bars cm.	15 Bars in.	A.W.C. cm.	A.W.C. in.	Hygr.Moist. cm.	Hygr.Moist. in.
	cm.	%	%	%	%	%	gm/cc		%										
L - F	5-0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Ah	0-12	6	28	45	27	8	.92	2.44	62.3	4.7	1.8	2.2	.8	1.4	.5	.8	.3	.3	.1
Bm	12-25	44	35	48	17	5	1.14	2.58	55.8	3.0	1.2	2.0	.8	1.3	.5	.7	.3	.1	.0
C	25-40	39	41	44	15	5	n.d.	2.58	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Rock	40+																		

Moisture Analysis columns: Sat. Cap., 1/3 Bars, 15 Bars, A.W.C., Hygr.Moist.

The Class A Alpine Dystric Brunisol has developed under larch forest while the Class B soil has developed under alpine sedge (Kobresia spp.) vegetation. The foregoing differences between these two soil profiles eliminate the Class B soil from being classified as an analog of the Sols ochres podzoliques in Europe (Duchaufour, 1965).

The morphological descriptions and analytical results for the Cumulic Regosol profile are shown in Tables XV and XVI. This soil is characterized by a very deep Ah horizon overlying a thin C horizon on top of bedrock. The solum has a slightly acid to neutral pH which increases progressively with increase in profile depth. Calcium is the dominant cation on the exchange complex of all horizons. Total carbon and total nitrogen contents of the A horizons are high but vary amongst horizons. C:N ratios are generally of the order of 20 to 30. Photomicrographs of thin sections (Plate 3, p. 68) indicate that the soil humus in the Ah horizons is of the moder type.

The characteristics of this soil are similar to those of the Atlantic Rankers described by Franz (1956) and of the Rankers subalpines ou cryptopodzoliques as classified by Duchaufour (1965). These similarities include a poorly differentiated A C type of profile, moder humus, and an Ah horizon depth greater than 8 inches.

B: Streeter Creek Basin

Land. Streeter Creek Basin is characterized by steep topography, savanna vegetation, relatively low precipitation, and the presence of Quaternary surficial deposits. Glacial till is the dominant surficial

TABLE XV. PROFILE DESCRIPTION OF SITE 6 - MARMOT CREEK BASIN

Classification: Cumulic Regosol

Elevation: 7260 ft.

Horizon	Depth (cm)	Color Dry	Color Moist	Texture	Structure	Consistence
Ah1	0-26	black 10 YR 2/1	black 10 YR 2/1	SiL	weak fine granular	very friable
Ah2	26-63	black 10 YR 2/1	black 10 YR 2/1	SiL	weak fine granular	very friable
Ah3	63-100	black 10 YR 2/1	black 10 YR 2/1	SiL	weak fine granular	very friable
C	100-110+	very dark gray to dark gray 10 YR 3/1-4/1	very dark brown 10 YR 2/2	SiL	single grained	very friable

TABLE XVI. ANALYTICAL CHARACTERISTICS OF THE CUMULIC REGOSOL AT SITE 6

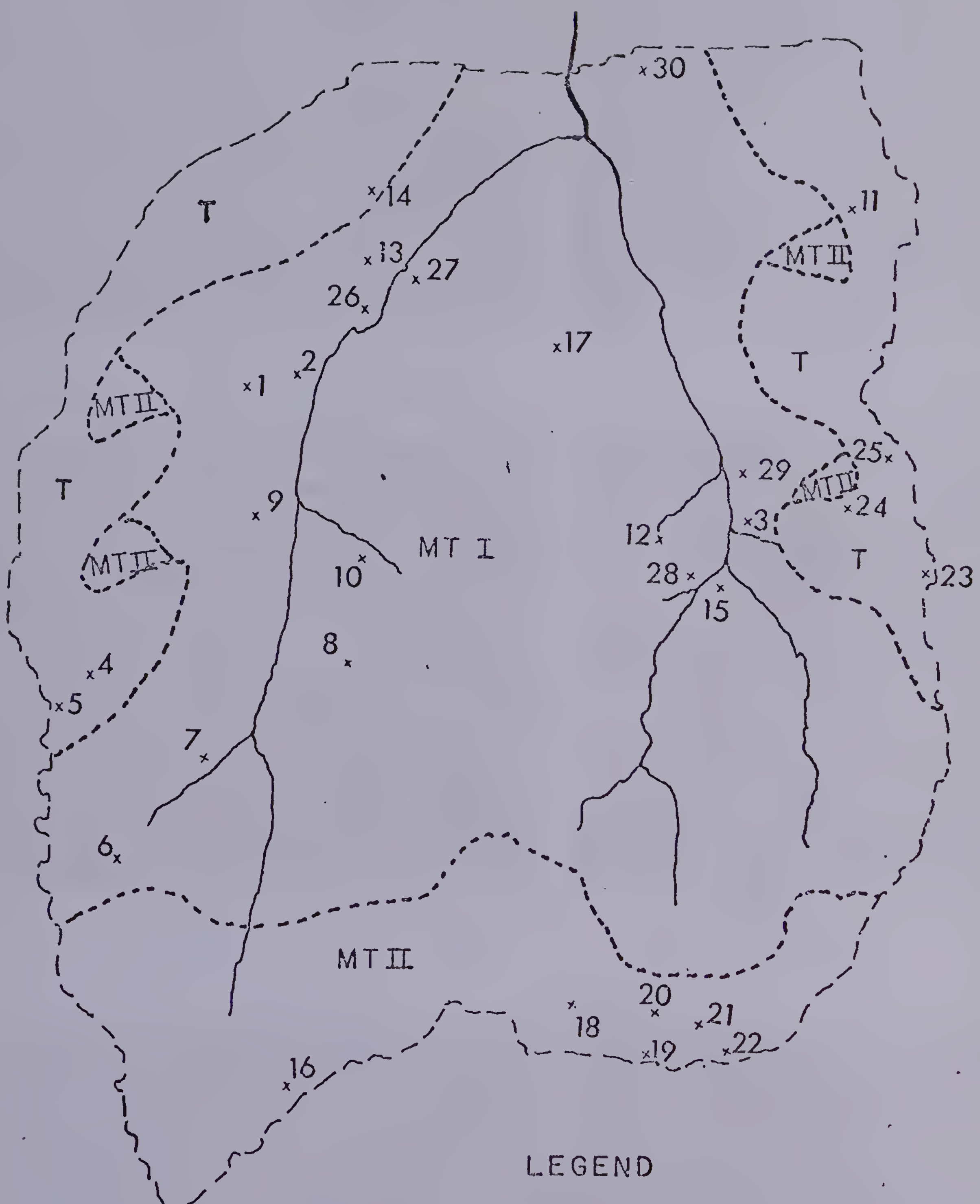
Horizon	Depth	pH	Tot.	Tot.	C/N	Exchange Analysis						pH-	Free Fe_2O_3			
			C	N	Ratio	Exch. Acid.	Na.	K	Ca	Mg	T.E.C.	Depend. C.E.C.	Oxalate		Citrate	
													Fe	Al	Fe	Al
	cm.					%	%	%	%	%	me/100gms	%	%	%	%	%
Ah1	0-26	6.3	11.3	.47	24	7	1	1	85	6	24.1	n.d.	n.d.	n.d.	n.d.	n.d.
Ah2	26-63	6.5	7.8	.31	25	3	0	1	84	12	26.2	n.d.	n.d.	n.d.	n.d.	n.d.
Ah3	63-100	6.7	10.3	.31	34	1	3	0	84	12	26.9	n.d.	n.d.	n.d.	n.d.	n.d.
C	100-110+	6.9	5.9	.19	n.d.	5	1	1	90	4	19.2	n.d.	n.d.	n.d.	n.d.	n.d.

Horizon	Depth	Mechanical Analysis					Bulk	Spec.	Poros.	Moisture Analysis									
		G	S	Si	C	FC	Dens.	Grav.		Sat. Cap.		1/3 Bars		15 Bars		A.W.C.		Hygr.Moist.	
	cm.	%	%	%	%	%	gm/cc		%	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.
Ah1	0-26	1	13	64	23	6	.74	2.29	67.7	12.1	4.1	4.6	1.8	3.9	1.5	.8	.3	n.d.	n.d.
Ah2	26-63	8	11	66	23	6	1.05	2.29	54.1	19.8	7.8	9.1	3.6	6.6	2.6	2.6	1.0	n.d.	n.d.
Ah3	63-100	6	15	62	23	7	.76	2.37	67.9	9.9	3.9	5.6	2.2	3.0	1.2	2.6	1.0	n.d.	n.d.
C	100-110	61	20	59	21	7	n.d.	2.52	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

deposit and was deposited by Laurentide as well as Cordilleran Ice Sheets. Tills derived from these two sources are locally intermixed in the basin. The occurrence or evidence of glacio-lacustrine deposits is attributed to the generally north-facing aspect of the basin which caused the development of glacial lakes at times of retreat or of stagnation in the advance of the ice mass. Postglacial colluvial deposits occur throughout the basin while alluvial deposits are found along the stream channels.

Laurentide till deposits occur above the mid-slope position in the northern half of the basin (Fig. 17). These deposits are characterized by neutral to alkaline pH, the presence of Orthic Black soils having thin sola, and by a grassland vegetation dominated by fescue (*Festuca idahoensis*) and oatgrass (*Danthonia parryi*). Smectite is the dominant clay mineral present with illite and kaolinite occurring in minor amounts (Fig. 18, p.120). This till is very compact (Plate 6, site S14) and contains a high percentage of coarse skeleton.

Mixed Till I was the term used to designate till deposits containing a mixture of Cordilleran and/or Laurentide till and glacio-lacustrine materials. These deposits are the most common parent materials in the basin. They are found south of the Laurentide till region and extend almost up to the ridge which marks the south-boundary of the basin (Fig. 17). This till is characterized by neutral to weakly acid pH values, a high degree of compaction (Plate 6, site S15), a relatively small amount of coarse skeleton, and soils having deep sola with strong, columnar macro-structure. The coarse skeleton fraction contains chiefly Cordilleran till erratics, i.e. Mississippian lime-



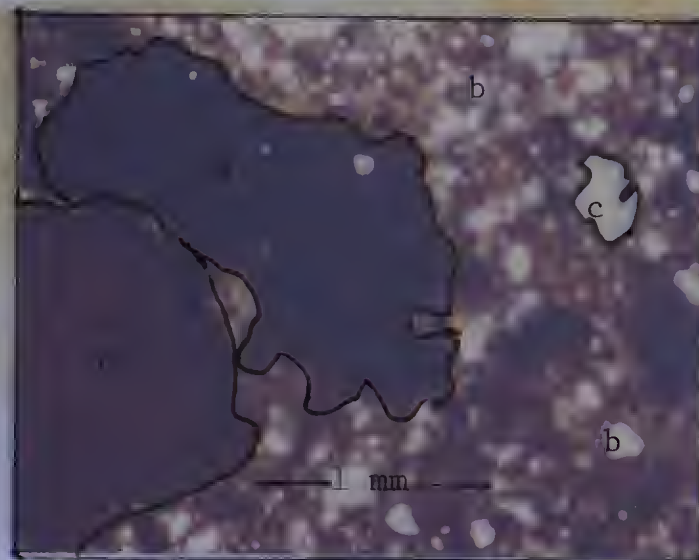
LEGEND

×5	Sampling location
T	Laurentide till
MT I	Mixed till I
MT II	Mixed till II

Figure 17. Sampling sites and distribution of till deposits in Streeter Creek Basin.

Plate 6. Photomicrographs of thin sections from Streeter Creek Basin

C horizon at site S14 (—>)

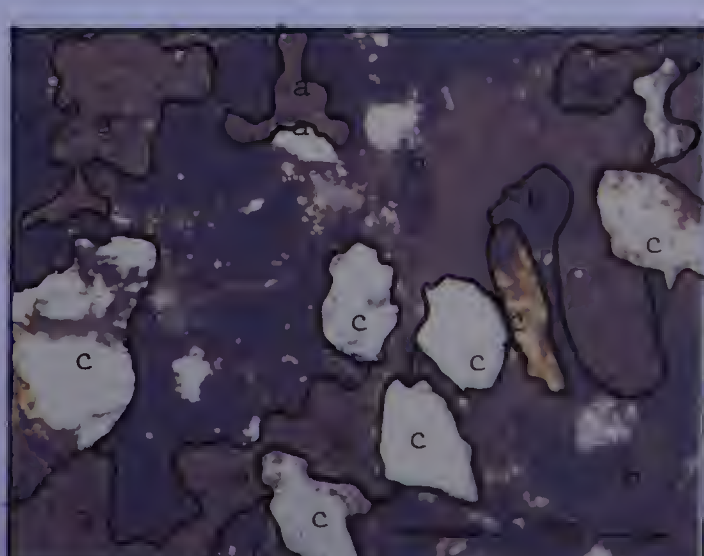


IIIC horizon at site S13 (—>)

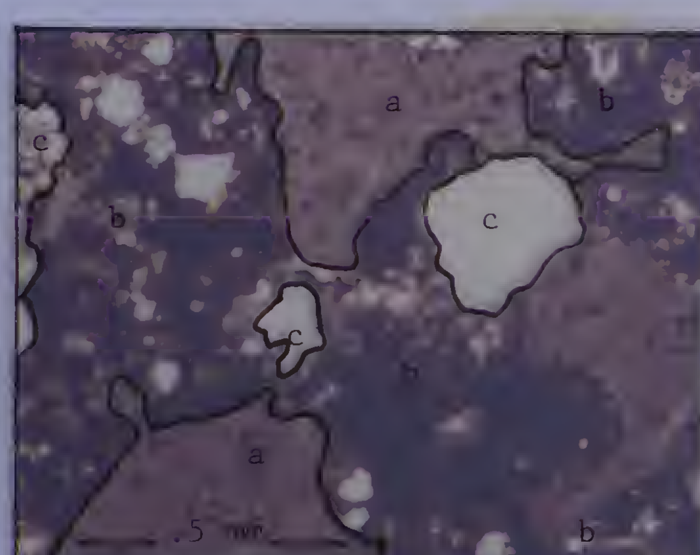
LEGEND: a). voids b). matrix c). large minerals

IIIC horizon at site S22 (--->)

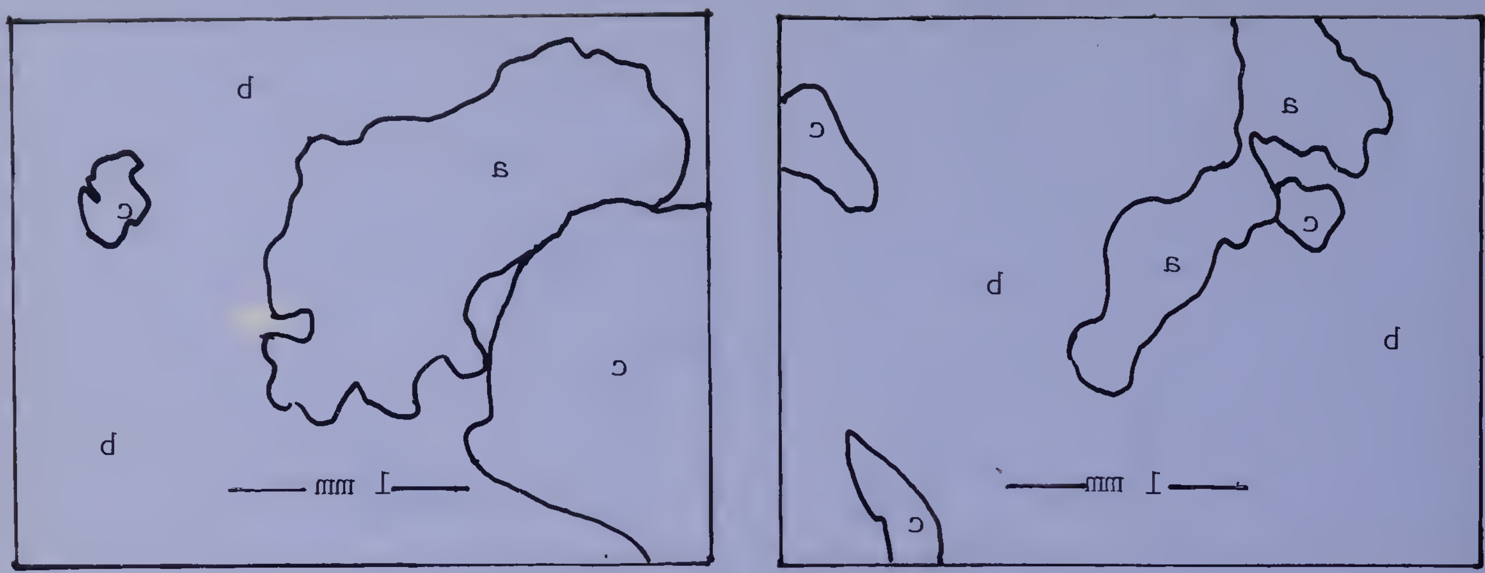
Ah horizon at site S14 (—>)



Ah horizon at site S19 (-->)



Ah horizon at site S28 (--->)



LEGEND: a). voids b). matrix c). large minerals

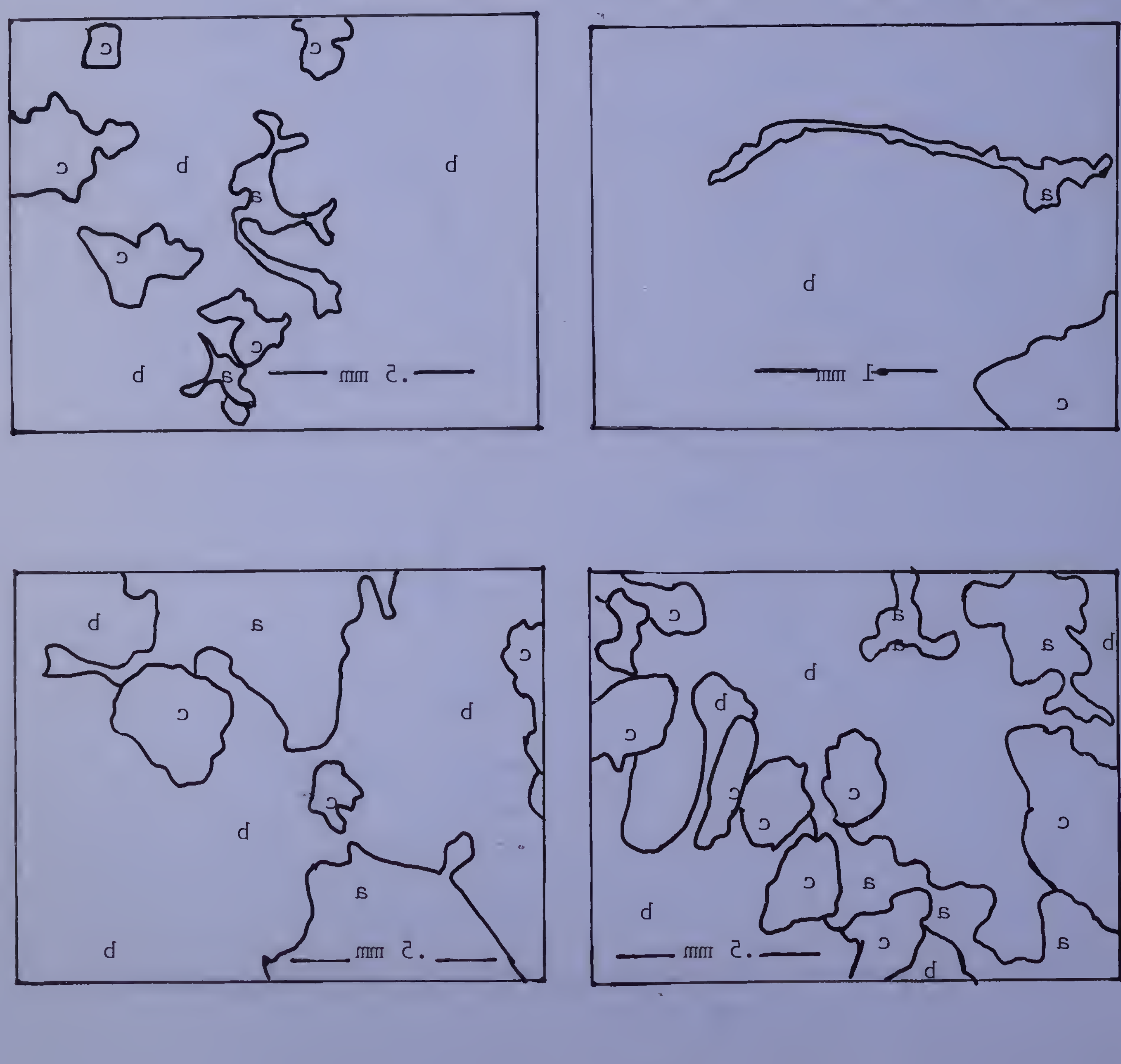
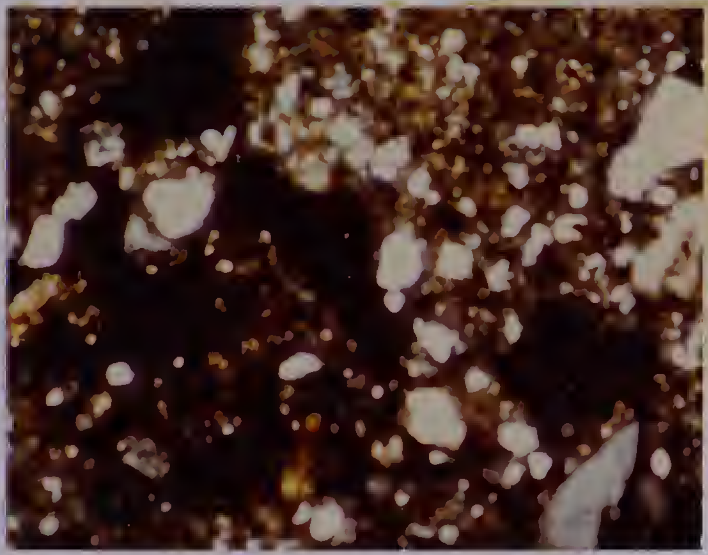
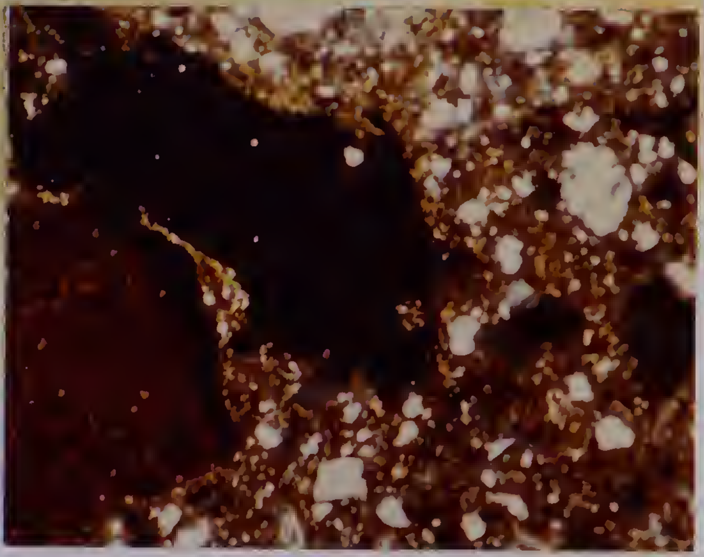


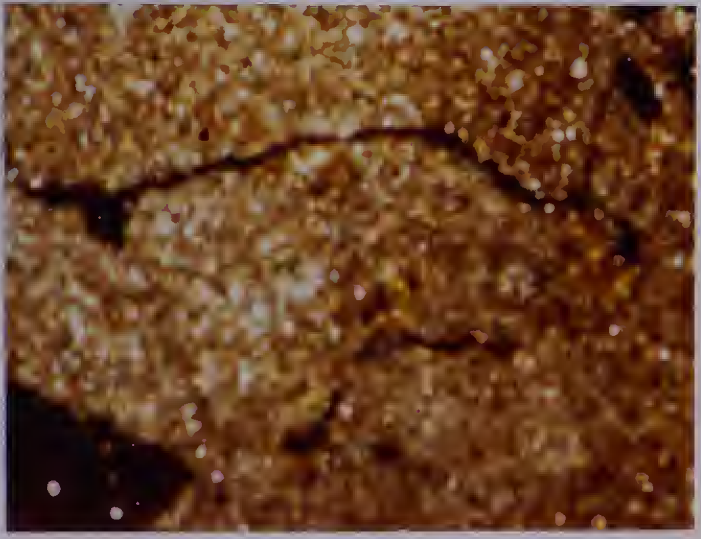
Plate 6. Photomicrographs of thin sections from Streeter Creek Basin



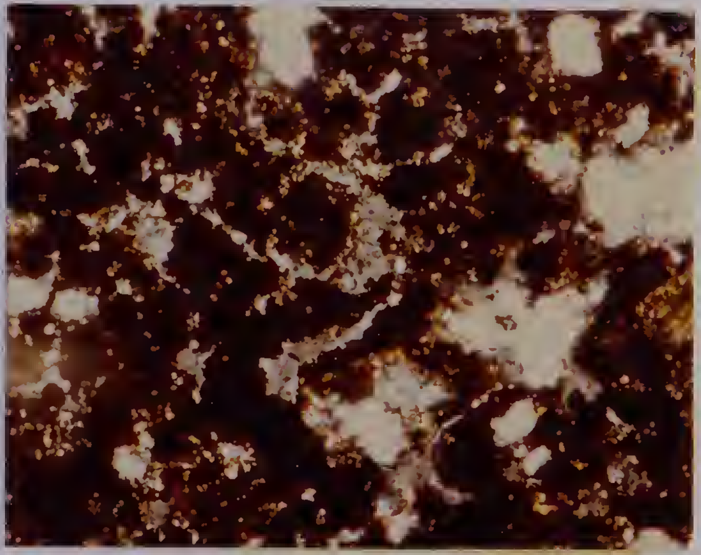
C horizon at site S14 (⟶)



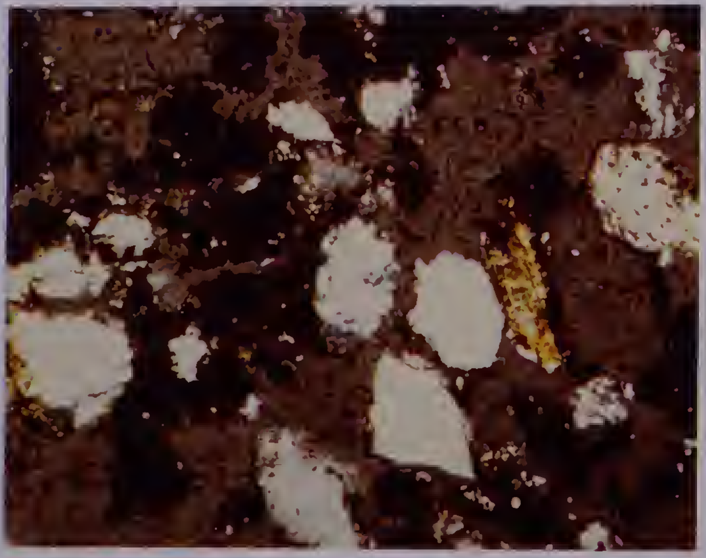
IIIC horizon at site S15 (⟶)



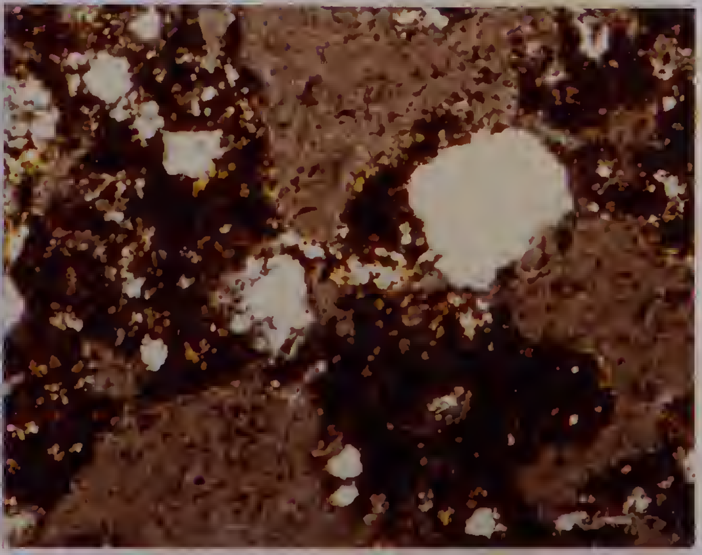
IIIC horizon at site S22 (⟶)



Ah horizon at site S14 (⟶)



Ah horizon at site S19 (⟶)



Ah horizon at site S28 (⟶)

DESCRIPTION OF PLATE 6

The photomicrographs of the C horizons show that these horizons have a dense matrix. The C horizon at site 14 and the IIIC horizon at site 15 have similar kinds of fabric, as is evident from the density of the matrices and the sizes and distributions of the skeleton grains. The IIICg horizon at site 22 has an extremely dense matrix containing many small skeleton grains.

The photomicrographs of the Ah horizons depict three types of fabric. The Ah horizon at site 14 has a relatively dense matrix in which the skeleton grains are closely bound to the plasmic material. In addition, the mineral and organic components of the plasma are fairly intimately associated with one another, which is indicative of a mull-like moder tending to a mull type of soil humus. The Ah horizon at site 19 has a loose matrix and has a micro-structure consisting of individual granules of plasmic material. The skeleton grains are relatively loosely bound to the plasmic material. Segregation of mineral and organic plasmic material is evident which suggests that the humus in this horizon is of the mull-like moder type, tending to the moder type. The micropedological features of the Ah horizon at site 28 are intermediate to those of the Ah horizon at sites 14 and 19. This Ah horizon has a loose soil matrix in which the skeleton grains are bound to the plasmic material. The nature of the association between the plasmic constituents is typic of a mull-like moder type of humus.

stone fragments. Granite erratics reflecting Laurentide till are also present. Smectite is the dominant clay mineral; kaolinite and illite are present in minor to trace amounts (Fig. 22, p.136).

Mixed Till II was the term used to designate a mixture of till and lacustrine deposits which contained a distinguishable amount of local, channery rock fragments. This soil forming parent material is found at the higher elevations in northerly-facing topographic positions (Fig. 17). It is characterized by neutral pH values, extreme compaction, the presence of sandstone fragments, and by deep soil sola. The assumed upper limit of the degree of compaction for this till phase is shown on the photomicrograph of the IIICg horizon at site S22 (Plate 6). Dominant clay minerals are smectite, vermiculite, illite and kaolinite (Fig. 20, p.129; Fig. 21, p.133).

Glacio-lacustrine deposits generally appear to have become incorporated into the till upon advancement of the glacier. Sandy disconformities between till deposits were assumed to be representative of former strand lines.

Postglacial colluvial deposits were observed to be separable on the basis of source material. Colluvium derived from till and from residuum were recognized in the basin. Till-colluvial deposits are normally thin while residual-colluvial deposits are quite thick. The latter are usually found near rock outcrops and tend to have a cumulic type of soil profile development. Residual colluvium is distinguishable from till colluvium by a more uniform particle size distribution and the dominance of channery fragments in the coarse skeleton.

Residual deposits were encountered on the higher ridge crests

of the basin. Mappable areas of sandstone and siltstone residuum were found; shale residuum was of minor significance. These residual deposits are associated with gently to moderately sloping terrain and generally support a grass vegetation dominated by fescue and oatgrass. The sandstone residuum is characterized by a sandy loam texture, the presence of channery rock fragments, and prominence of kaolinite clay (Fig. 19, p.124). Siltstone residuum is characterized by an uniform silt loam texture, an alkaline reaction and the absence of coarse skeleton.

Alluvial deposits were found chiefly in the lower reaches of the basin along the drainage channels. These deposits usually support a grass vegetation dominated by timothy (*Phleum pratense*) and have soils belonging to the Gleysolic and Chernozemic Order. The deposits are characterized by the presence of various strata exhibiting variable degrees of sorting. Alluvial fan deposits were encountered at the foot of steep erosion channels and were characterized by neutral to alkaline pH values. Soils developed on alluvial deposits are generally very deep, sometimes exceeding 4 feet.

Soils. The enclosed soil map of Streeter Creek basin presents an outline of the soils occurring in the area. The soils are grouped according to Subgroup or Subgroup Class classification. The Subgroup classes were not delineated as separate entities on the map but were considered as complexes on the basis of profile and/or classification similarities. As a consequence, Montane and Montane Eluviated Black soils are presented by a single designation. Similar Subgroup Class combinations were used for the Eroded and Thin Orthic Blacks, the Deep and Cumulic Orthic

Blacks, the Cumulic Rego, Carbonated Rego, and Carbonated Cumulic Rego Blacks, and the Dark Gray analogs of the Black soil groupings. A total of 14 soil groupings are outlined on the map, ranging from Orthic Regosols to Orthic Gray Luvisols. The location of the sampling sites of the mapping units are shown in Figure 17. Detailed morphological descriptions and analytical results for each of the sampled profiles are presented in Appendix II-B.

The soil map shows that the soil pattern is very complex in this basin. There is no evidence of vertical zonation of soils; however, the distribution does reflect the biotic factor. Degraded Eutric Brunisols, Dark Gray Chernozems, Dark Gray Luvisols and Orthic Gray Luvisols are always found under forest vegetation. All other soils are generally found under grassland vegetation but may occur under forest vegetation. Deep and Cumulic Black Chernozemic soils usually occur below the mid-slope position while Thin, Eroded, Eluviated Montane, and Montane Orthic Blacks are encountered above the mid-slope position. Soils under forest apparently have no distinct distribution pattern.

Gray Luvisol (formerly Gray Wooded) soils in the basin belong to the Orthic or Dark Subgroups. Soils of both Subgroups are generally located in moderately to strongly sloping positions in the discharge area of the regional groundwater system. They are generally developed in thin colluvial deposits overlying "mixed till" material. This colluvial deposit is usually less than 6 in. thick in the Orthic Gray Luvisols and may exceed 1 ft. in the Dark Gray Luvisols. Orthic Gray Luvisols are associated with black poplar (Populus trichocarpa) forest vegetation and occupy an elevational position on the regional slope

below that of the Dark Gray Luvisols.

Eutric Brunisol soils in the survey area were all found to belong to the Degraded Subgroup. These Degraded Eutric Brunisols are normally encountered above the mid-slope positions of the basin. They are generally located in the moderately to strongly sloping, local ground-water discharge areas which constitute part of the regional groundwater recharge area. Degraded Eutric Brunisols which occupy these topographic positions are characterized by a thin colluvial deposit overlying till-derived material. These soils can be considered as topographic analogs of the Orthic Gray Luvisols.

Dark Gray Chernozemic soils in the basin are generally found above the basin mid-slope positions under trembling aspen (*Populus tremuloides*) vegetation. These soils are developed from deep colluvial deposits overlying till or bedrock. The colluvial material is usually derived from residuum which may be the reason for the grayish brown colour of the Ah horizons. Thin Orthic Dark Gray soils are normally encountered at the ridge crests while Deep Orthic Dark Gray soils are found downslope from the crests. Cumulic Orthic and Rego Dark Grays occur at the base of slopes near rock outcrops.

Black Chernozemic soils are the dominant soils in the basin. The Subgroup Classes recognized were Montane Orthic, Montane Eluviated, Thin, Eroded, Deep and Cumulic Orthic or Rego Black. Soils belonging to the Montane, Eroded, and Thin Orthic Black Classes are usually found above the mid-slope position. These soils are associated with fescue-oatgrass grassland vegetation. The Montane Orthic Blacks were delineated on the basis of the "fluffy" consistence of the Ah horizon. Eroded

Orthic Blacks were distinguished by the presence of an Ah horizon less than 3 in. thick and Thin Orthic Blacks by an Ah horizon having a thickness ranging from 3 to 6 inches. Deep and Cumulic Blacks are generally found below the mid-slope position. These soils usually support timothy grass in the valley bottoms and a mixture of grasses and forbs on the slope positions. The separation of Deep from Cumulic Blacks is arbitrarily based on Ah horizon thicknesses ranging from 6 - 12 in. and greater than 12 inches, respectively. Most of the Deep Black soils were found to have a cumulic Ah horizon.

Regosolic soils belong to the Orthic and Cumulic Subgroups. The Orthic Regosols were separated into Classes on the basis of presence or absence of a non-chernozemic Ah horizon. Those Orthic Regosols which have a non-chernozemic Ah horizon were formerly classified in the Deorcic Regosols Subgroup (N.S.S.C., 1965). Orthic Regosols are generally characterized by a thin solum overlying bedrock and occur on steeply to very steeply sloping terrain which supports a sparse stand of limber pine (Pinus flexilis). Cumulic Regosols occur on very steep slopes under trembling aspen vegetation. These soils are characterized by deep, non-chernozemic Ah horizons which are usually over 1 foot thick. Bedrock is normally encountered within 36 inches of the land surface.

Imperfectly and poorly drained soils in Streeter Creek Basin could not be classified properly by the Canadian System of Soil Classification (N.S.S.C., 1968). Mottling and/or gleying are generally poorly expressed in such soils (Appendix II-B). As a consequence, these soils cannot be classified at either the (Gleyed) Subgroup or the (Gleysolic) Order level. Analogous to the recommendation for soils in

Marmot Creek Basin, it is suggested that soil drainage be determined according to the position of the soil in the groundwater system.

Analytical results for the Chernozemic soils in the basin (Appendix II-B) show considerable variation in the characteristics of the Ah horizons amongst such soils. Thin Orthic Black soils generally contain more total carbon and have a higher cation exchange capacity in their Ah horizon than is present in the Ah horizon of the Montane, Deep, and Cumulic Blacks. This can be explained by the residual or colluvial nature of the parent material in which the Ah horizon of the latter soils developed. The total carbon contents and cation exchange capacities of Deep and Cumulic Dark Gray soils are even lower than that of their Black Chernozem counterparts. This can be accounted for by the more active deposition of colluvial material in the Dark Gray soils as compared to the Black Chernozems.

The variations in total carbon content of the chernozemic Ah horizons are distinguishable in the field by differences in soil consistence. A soft and "fluffy" consistence is associated with a low total carbon content, while a slightly hard to hard consistence is associated with high amounts of total carbon. The soft and "fluffy" consistence is most pronounced in the Montane Orthic Black soils and is evident to a lesser degree in the Dark Gray and Cumulic Black soils. Thin section studies (Plate 6, p. 107) suggest that the consistence of chernozemic Ah horizons is indicative of the type of soil humus present. The soft and "fluffy" consistence of the Ah horizon from the Montane Orthic Black soil at site S19 reflects a mull-like moder type of humus which tends towards moder humus. The slightly hard to hard consistence of the Ah horizon from the Thin Orthic Black soil at site S14 reflects a mull-like

moder type of humus which tends towards mull humus. A typic mull-like moder type of soil humus is present in the Ah horizon of the Cumulic Orthic Black soil at site S28. Density - fractionation of the organic matter (Henin and Turc, 1950) from the afore-mentioned Ah horizons indicates that soils with a "fluffy" consistence contain appreciable amounts of unhumified organic material. This, as well as results reported by Dudas (1968), provide support for the mull-like moder nature of the humus in the Ah horizon of Chernozemic soils from this basin.

The morphological description of well-drained soils in the basin (Appendix II-B) show a progressive increase in podzolization from the Orthic Black Chernozem soils to the Orthic Gray Luvisol soils. The transformations in morphology resemble those reported by Beke (1964) and by St. Arnaud and Whiteside (1964). This increase in podzolization is also reflected in the analytical soil characteristics (Appendix II-B). The pH of the upper horizons in the solum and the organic matter content of the A horizons decrease from the Orthic Black Chernozems to the Orthic Gray Luvisols. This is accompanied by a progressive increase in the total exchange capacity and in the extractable iron and aluminum content of the B horizons. Similar results have been reported for Chernozemic to Podzolic sequences of soil profiles from Saskatchewan (St. Arnaud and Mortland, 1963) and Manitoba (Beke, 1964). A detailed study by Dormaar and Lutwick (1966) on selected soils of Streeter Creek Basin supports the occurrence of progressive podzolization in these soils. Changes in soil organic matter and constituent humic acids were found to reflect the advent of podzolization more strikingly than other

soil characteristics.

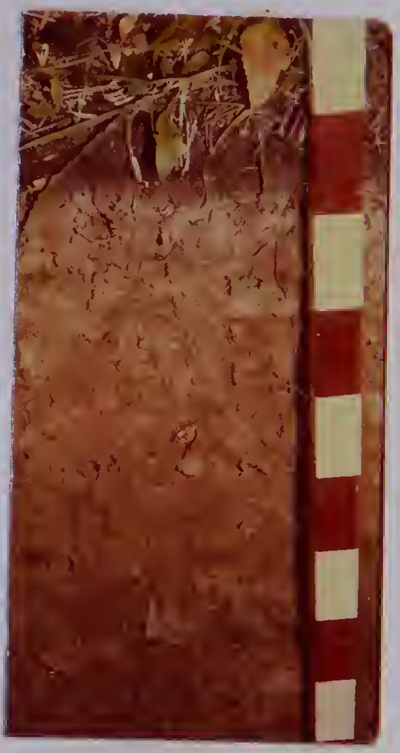
The soil sampling sites selected to represent the variation in soil development are sites 14, 15, 18, 19 and 22 (Fig. 17). The soils at these sites, when arranged according to increasing degree of podzolic degradation are: Thin Orthic Black (site 14), Montane Orthic Black (site 19), Dark Gray Luvisol (site 22), Degraded Eutric Brunisol (site 18), and Orthic Gray Luvisol (site 15).

The morphological description and analytical results for the Thin Orthic Black profile are presented in Tables XVII and XVIII, respectively. This soil is characterized by a truncated Ah horizon which has an overall thickness of less than 6 inches. The solum is medium acid to neutral in reaction with the Bt1 horizon being the most acid horizon in the profile. Cation exchange capacities decrease with increase in profile depth. Calcium is the dominant cation on the exchange complex of all horizons. The Ah horizon contains a normal organic carbon content and has a C:N ratio which is characteristic for Chernozemic soils (Russel, 1961). A distinct accumulation of clay and citrate-extractable iron is evident in the Bt1 horizon.

Accumulation of extractable iron in the solum as compared to the parent material suggests that in situ release due to weathering of minerals is active in this soil. The higher extractable iron content in the Ah horizon as compared to the Bt2 horizon indicates that translocation is not taking place. There is also no evidence of clay mineral weathering from the diffraction patterns (Fig. 18), although the diffractogram of the glycolated Ah horizon sample is distinctly different from those of the other horizons in the solum. A broad shouldered 17 Å

Plate 7. Photographs of soil profiles from Streeter Creek Basin.

Thin Orthic Black (site S14)



Degraded Eutric Brunisol (site S18)

Dark Gray Luvisol (site S22)

Orthic Gray Luvisol (site S15)

TABLE XVII. PROFILE DESCRIPTION OF SITE 14 - STREETER CREEK BASIN

Classification: Thin Orthic Black

Elevation: 4530 ft.

Horizon	Depth (cm)	Color Dry	Color Moist	Texture	Structure	Consistence
L - F	2-0					
Ah	0-8	very dark gray 10 YR 3/1	black 10 YR 2/1	CL	medium prismatic to fine S.A. blocky	friable
Bt1	8-26	yellowish brown 10 YR 5/4	dark grayish brown to brown 10 YR 4/2-4/3	C	medium subang. blocky	firm
Bt2	26-57	yellowish brown to light yellowish brown 10 YR 5/4-6/4	brown to dark brown 10 YR 4/3	CL	strong medium subang. blocky	firm
Cca	57-100+	light gray to very pale brown 10 YR 7/2-7/3	grayish brown to light brownish gray 10 YR 5/2-6/2	CL	amorphous	firm

TABLE XVIII. ANALYTICAL CHARACTERISTICS OF THE THIN ORTHIC BLACK AT SITE 14

Horizon	Depth	pH	Tot. C	Tot. N	C/N Ratio	Exchange Analysis: Exch. Acid.	Na	K	Ca	Mg	T.E.C.	pH-Depend. C.E.C.	Free Fe_2O_3: Oxalate Fe	Oxalate Al	Citrate Fe	Citrate Al
	cm		%	%		%	%	%	%	%	me/100gms	%	%	%	%	%
L - F	2-0	6.9	21.7	1.6	n.d.	7	0	5	87	1	66.1	n.d.	n.d.	n.d.	n.d.	n.d.
Ah	0-8	6.4	8.0	.7	11	12	0	5	78	4	43.6	n.d.	n.d.	n.d.	.63	.01
Bt1	8-26	5.8	1.7	.1	17	9	0	4	76	11	31.7	n.d.	n.d.	n.d.	.78	.02
Bt2	26-57	6.0	1.9	.1	19	8	0	3	78	11	24.3	n.d.	n.d.	n.d.	.50	.02
Cca	57-100+	7.8	2.4	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	17.4	n.d.	n.d.	n.d.	n.d.	n.d.

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Spec. Grav.	Poros.	Moisture Analysis: Sat. Cap.	Sat. Cap.	1/3 Bars	1/3 Bars	15 Bars	15 Bars	A.W.C.	A.W.C.	Hygr.Moist.	Hygr.Moist.
	cm	%	%	%	%	%	gm/cc		%	cm	in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.
L - F	2-0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Ah	0-8	1	24	39	37	11	.89	2.19	59.4	5.3	2.0	2.7	1.0	2.0	.7	.7	.3	.3	.1
Bt1	8-26	0	22	30	48	28	1.08	2.50	56.8	7.7	3.0	5.0	1.9	3.4	1.3	1.6	.6	.7	.3
Bt2	26-57	2	28	36	36	18	1.06	2.56	58.6	12.1	5.1	9.0	3.8	4.4	2.0	4.6	1.8	1.0	.4
Cca	57-100+	2	33	37	30	7	1.40	2.57	45.5	19.9	7.9	11.6	4.6	6.4	2.6	5.2	2.0	1.7	.7

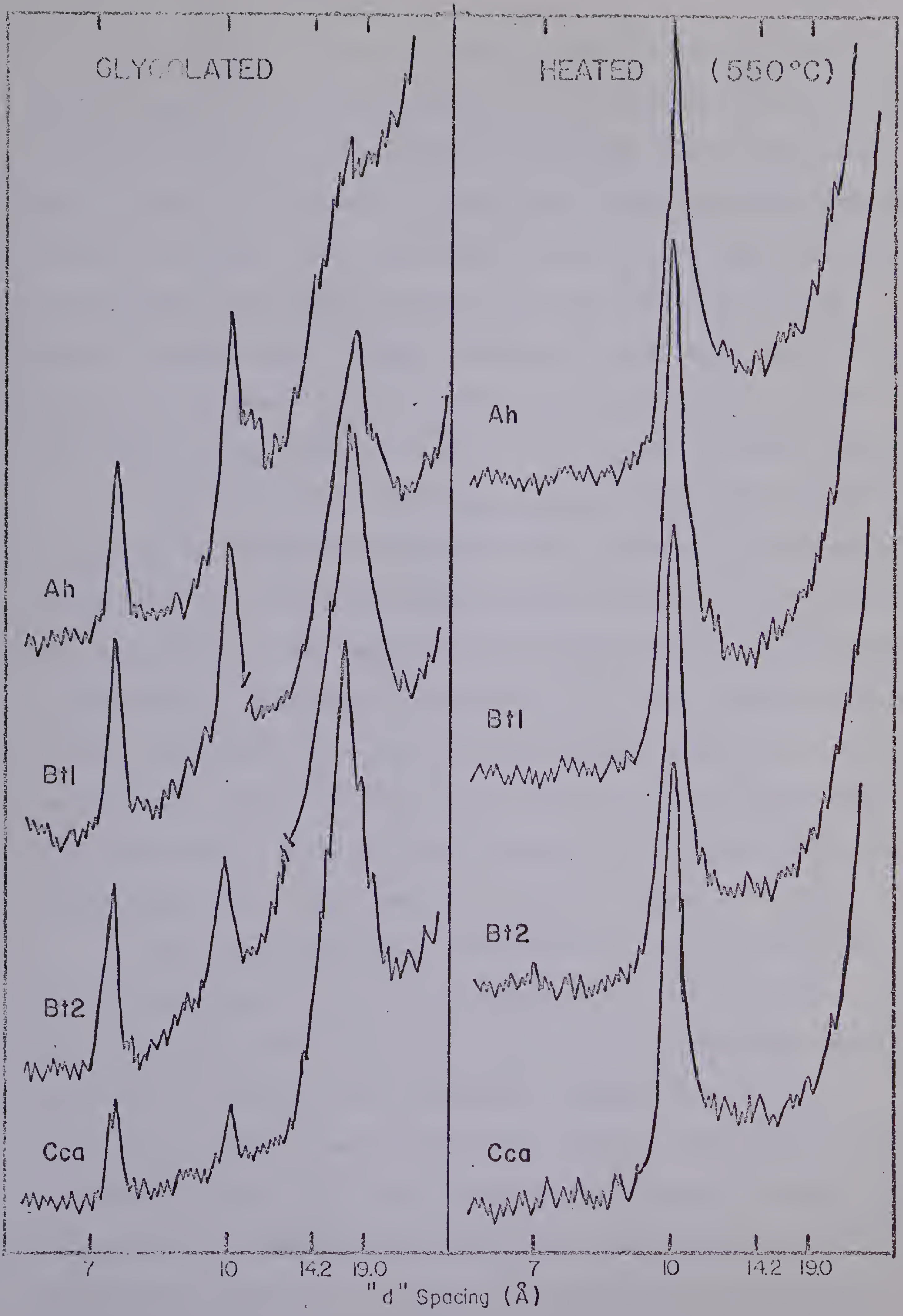


Figure 18. X-ray diffraction patterns of the total clay fraction from the major horizons of the Thin Orthic Black profile.

reflection is evident on the diffraction pattern of the glycolated sample of the Ah horizon as compared to a sharp reflection in those of the B and C horizons. Brown (1961) has suggested that this broad peak may be caused by the presence of organic molecules in the interlattice spacings of smectite while White (1950) has shown that weathered illite could produce such a peak. The more likely explanation is that of organic interlayering. The high proportion of smectite in the clay fraction of the lower horizons in the profile appears to be characteristic for soils developed in Laurentide till (Kodama and Brydon, 1964).

Characteristics of the Montane Orthic Black profile include uniform horizon thicknesses (Table XIX) and a medium acid soil reaction (Table XX). Total carbon and total nitrogen contents as well as cation exchange capacities decrease progressively with increase in depth within the profile. Calcium is the dominant cation on the exchange complex; although, the solum has an unusually high exchange acidity for a Chernozemic soil. The Btj horizon has the lowest pH and a slightly higher clay content than the other horizons in the profile. Extractable sesquioxides remain practically constant in content throughout the profile.

The minor variations in the quantities of sesquioxides are principally attributable to oxalate-extractable aluminum. Unlike other Chernozemic soils (Beke, 1964; St. Arnaud and Whiteside, 1964), aluminum is the major oxalate-extractable sesquioxide in this soil. Degradation of clay is not readily evident from the diffraction patterns for this soil (Fig. 19). However, diffraction patterns of the glycolated samples show that the Ah horizon sample has a weak, broad 14 to 17 Å reflection as opposed to the strong, sharp peak on the diffractograms of the other horizons, The broadness of the reflection is considered

TABLE XIX. PROFILE DESCRIPTION OF SITE 19 - STREETER CREEK BASIN

Classification: Montane Orthic Black   Elevation: 5255 ft.

Horizon	Depth (cm)	Color Dry	Color Moist	Texture	Structure	Consistence
L - F	2-0					
Ah	0-17	very dark grayish brown 10 YR 3/2	black 10 YR 2/1	L	strong medium prismatic	very friable
Btj	17-36	yellowish brown 10 YR 5/4	dark brown to brown 10 YR 3/3-4/3	L	weak prismatic	friable
C	36-55	grayish brown to brown 10 YR 5/2-5/3	brown to grayish brown 10 YR 4/3-5/2	L	amorphous	very friable
Rock	55+					

TABLE XX. ANALYTICAL CHARACTERISTICS OF THE MONTANE ORTHIC BLACK AT SITE 19

Horizon	Depth	pH	Tot. C	Tot. N	C/N Ratio	Exchange Analysis						pH-Depend. C.E.C.	Free Fe_2O_3			
						Exch. Acid.	Na	K	Ca	Mg	T.E.C.		Oxalate Fe	Oxalate Al	Citrate Fe	Citrate Al
	cm		%	%		%	%	%	%	%	me/100gms	%	%	%	%	%
L - F	2-0	6.2	20.0	1.25	n.d.	15	0	4	76	5	55.8	n.d.	n.d.	n.d.	n.d.	n.d.
Ah	0-17	5.9	5.5	.53	10	29	0	3	65	3	25.7	n.d.	.08	.09	.66	.01
Btj	17-36	5.5	1.9	.13	14	28	0	2	68	2	15.6	n.d.	.06	.10	.61	.03
C	36-55	5.7	1.5	n.d.	n.d.	31	0	2	59	8	11.7	n.d.	.05	.05	.64	.01
Rock	55+															

Horizon	Depth	Mechanical Analysis					Bulk Dens.	Spec. Grav.	Poros.	Moisture Analysis									
		G	S	Si	C	FC				Sat.	Cap.	1/3 Bars		15 Bars		A.W.C.		Hygr.Moist.	
	cm	%	%	%	%	%	gm/cc		%	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.
L - F	2-0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Ah	0-17	1	49	34	17	9	.98	2.36	58.5	11.7	4.8	4.2	1.7	3.2	1.3	1.0	.4	.4	.2
Btj	17-36	1	40	37	23	11	1.17	2.54	53.9	6.6	2.4	3.9	1.5	2.0	.8	1.9	.7	.5	.2
C	36-55	13	48	34	18	8	1.26	2.57	51.0	8.2	3.5	4.1	1.7	2.0	.9	2.1	.8	.5	.2
Rock	55+																		

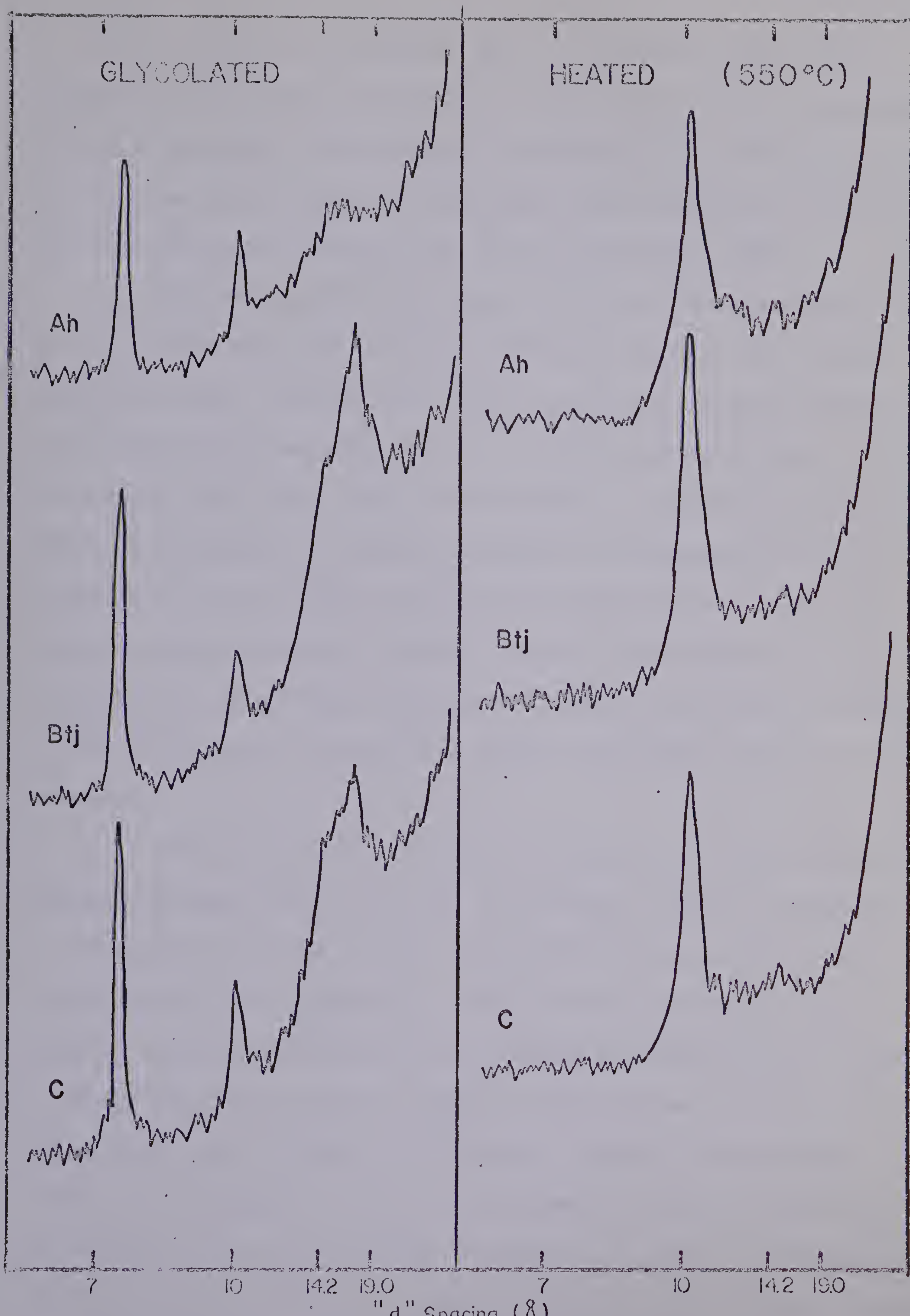


Figure 19. X-ray diffraction patterns of the total clay fraction from the horizons of the Montane Orthic Black profile.

to indicate organic interlayering, while its weakness suggests that breakdown of the smectite structure is taking place with the concurrent release of aluminum. The dominance of smectite clay in this profile and the prominence of kaolinite clay reflect the clay mineral distribution in the parent rock material (Carrigy and Mellon, 1964).

The characteristics of this profile meet the requirements of an Orthic Black Chernozem as established by the National Soil Survey Committee (1968). However, the "fluffy" consistence when dry and the relatively high exchangeable acidity are not characteristic for Chernozemic soils (Beke, 1964; Dudas, 1968; St. Arnaud and Whiteside, 1964). Considering the climatic conditions at the sampling location, this soil is likely to have developed under cold climatic conditions representative of subalpine regions. However, the vegetation is not characteristic of subalpine regions, so that this soil cannot be excluded from the Chernozemic Order on the basis of vegetation and perhaps of climate.

The morphological description and analytical results for the Dark Gray Luvisol profile are shown in Tables XXI and XXII, respectively. The upper solum has a medium to slightly acid pH and the soil is characterized by the presence of a thick Ah horizon overlying an Ae horizon. The pH values in the solum decrease progressively with increase in profile depth up to and including the IIBt1 horizon, whereupon they become more basic. Calcium is the dominant cation on the exchange complex of all horizons. The Ae horizon generally has less than half the exchange capacity of the other horizons in the solum. Accumulation of citrate-extractable iron is evident in the B horizons. These results agree with those reported for similar soils from Saskatchewan (St. Arnaud

TABLE XXI. PROFILE DESCRIPTION OF SITE 22 - STREETER CREEK BASIN

Classification: Dark Gray Luvisol Elevation: 5240 ft.

Horizon	Depth (cm)	Color Dry	Color Moist	Texture	Structure	Consistence
L - H	8-0					
Ah	0-16	grayish brown 10 YR 5/2	v.d. grayish brown 10 YR 3/2	L	strong medium prismatic	friable
Ae	16-27	light yell. brown 10 YR 6/4	brown to yell. brown 10 YR 4/3-5/4	SiL	strong medium platy	very friable
IIBt1	27-54	pale brown 10 YR 6/3	d. grayish brown to brown 10 YR 4/2-4/3	SiCL	strong medium subang. blocky	very firm
IIBt2	54-77	brown to pale brown 10 YR 5/3-6/3	d. gray and yell. brown 10 YR 4/1+5/4	SiC	strong medium subang. blocky	very firm
IIIBCg	77-109	gray to light gray 10 YR 6/1	gray 10 YR 5/1	SiC	strong fine subang. blocky	firm
IIICg	109-114+	gray to light gray 10 YR 6/1	gray 5 Y 5/1	SiC	pseudo platy	firm

TABLE XXII. ANALYTICAL CHARACTERISTICS OF THE DARK GRAY LUVISOL AT SITE 22

Horizon	Depth	pH	Tot. C	Tot. N	C/N Ratio	Exchange Analysis Exch. Acid.	Na	K	Ca	Mg	T.E.C.	pH-Depend. C.E.C.	Free Fe_2O_3 Oxalate Fe	Oxalate Al	Citrate Fe	Citrate Al
	cm		%	%		%	%	%	%	%	me/100gms	%	%	%	%	%
L-H	8-0	6.4	27.9	1.52	18	7	0	3	84	5	90.4	n.d.	.04	.00	n.d.	n.d.
Ah	0-16	6.3	3.0	.24	13	13	1	6	80	0	20.1	n.d.	.08	.06	.47	.00
Ae	16-27	6.0	.7	.07	10	18	1	2	77	1	10.2	n.d.	.05	.04	.72	.01
IIBt1	27-54	5.6	.6	.06	10	10	1	2	80	8	21.6	n.d.	.05	.01	n.d.	n.d.
IIBt2	54-77	5.9	.8	.07	11	7	1	2	79	11	23.4	n.d.	.05	.05	1.50	.05
IIIBCg	77-109	7.7	2.9	.06	n.d.	0	0	1	99	0	19.3	n.d.	.03	.00	n.d.	n.d.
IIICg	109-114	7.8	n.d.	n.d.	n.d.	0	0	1	99	0	18.0	n.d.	.04	.03	.87	.02

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Spec. Grav.	Poros.	Moisture Analysis Sat.	Cap.	1/3 Bars		15 Bars		A.W.C.		Hygr.Moist.	
	cm	%	%	%	%	%	gm/cc		%	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.
L-H	8-0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Ah	0-16	0	27	51	22	6	1.09	2.46	55.7	6.8	2.5	4.1	1.5	2.2	.7	1.9	.8	.7	.2
Ae	16-27	0	24	57	19	7	1.15	2.61	55.9	3.3	1.2	2.3	1.0	1.0	.5	1.3	.5	.2	.1
IIBt1	27-54	3	12	49	39	23	1.44	2.54	43.3	13.1	5.3	9.0	3.6	5.5	2.2	3.5	1.4	1.5	.6
IIBt2	54-77	1	4	53	43	22	1.44	2.60	44.6	11.6	4.5	9.1	3.5	5.2	2.0	3.9	1.5	1.2	.5
IIIBCg	77-100	10	1	47	52	17	1.51	2.58	41.5	15.3	6.2	10.2	4.2	6.0	2.6	4.2	1.6	1.6	.7
IIICg	109-114	2	1	53	46	17	1.56	2.60	40.0	2.6	1.0	1.8	.7	.9	.3	.9	.4	.2	.1

and Whiteside, 1964).

Degradation of the Ae horizon is suggested by the low exchange capacity, although other results indicate that degradation of this horizon is relatively weak. The higher citrate-extractable iron and insignificant decrease in clay content of the Ae horizon as compared to the Ah horizon indicates that the low exchange capacity of the Ae horizon is chiefly due to the lack of organic matter. Limited weathering of the Ae horizon is also evident from X-ray diffraction results (Fig. 20). The glycolated sample of the Ae horizon has a broad, 14 to 20 Å reflection on its diffraction pattern which is considered to indicate interstratification of clay minerals (Jackson, 1956). Correspondingly, diffractograms of the Ah horizon, show broad 14 Å and 17 Å peaks indicative of organic interlayering as previously suggested.

The X-ray diffraction patterns of the major horizons of this profile reflect the influence of the source material. Kaolinite clay is very prominent in the Ah and Ae horizons which is characteristic of the residual colluvium material in which these horizons developed. Smectite and vermiculite are the dominant clay minerals in the IIBt2 horizon developed in mixed till II material. The weathered shale parent material of the IIIC horizon contains a similar clay mineral suite as the mixed till II, although the components are present in lower quantities.

The characteristics of the <u>Degraded Eutric Brunisol</u> soil include a weakly expressed Aej horizon (Table XXIII) and a very strongly to strongly acid solum (Table XXIV). Upper horizons in this solum have a relatively high exchange acidity and low total exchange capacity. The soil is highly base saturated as determined by NaCl extractions, with

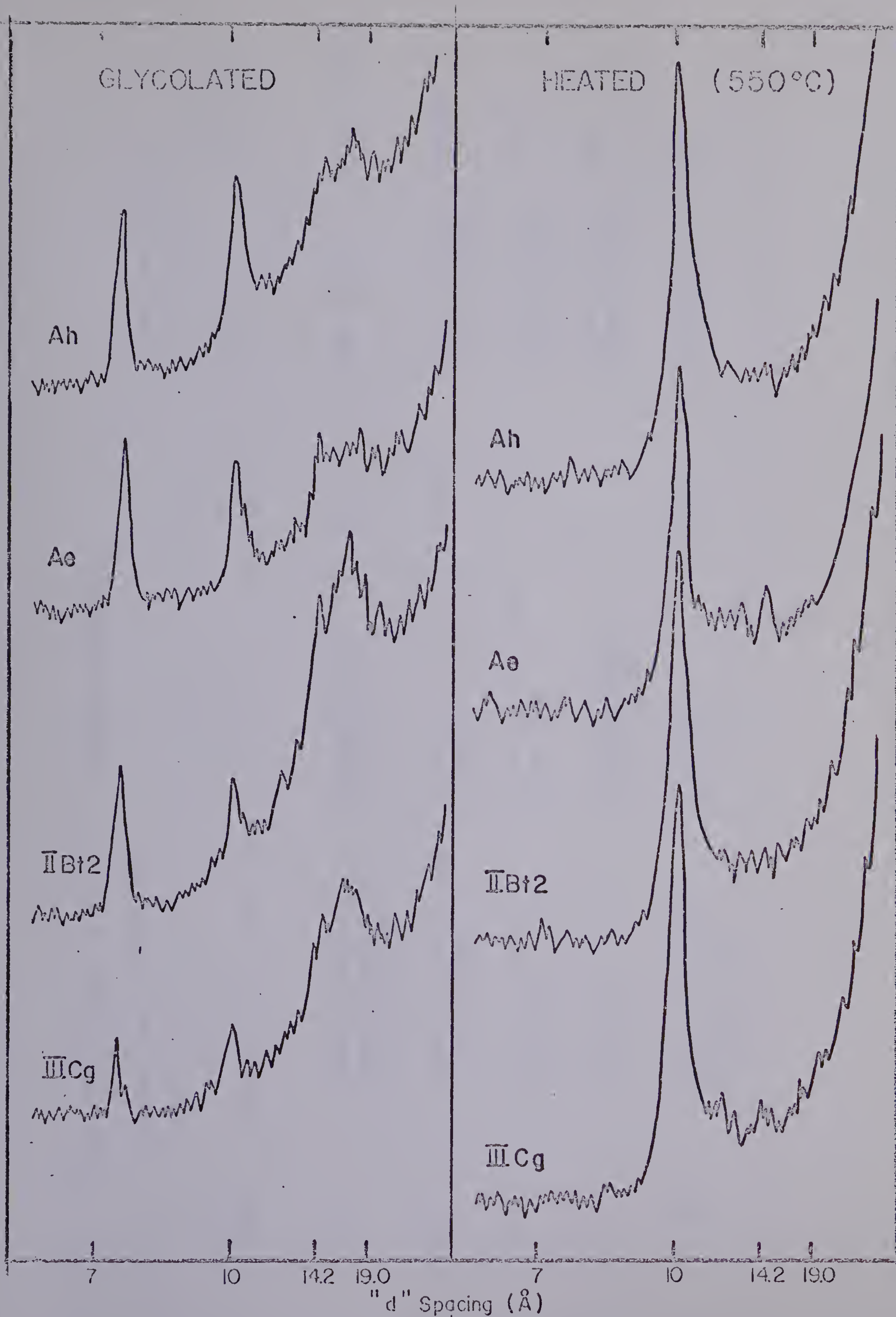


Figure 20. X-ray diffraction patterns of the total clay fraction from the major horizons of the Dark Gray Luvisol profile.

TABLE XXIII. PROFILE DESCRIPTION OF SITE 18 - STREETER CREEK BASIN

Classification: Degraded Eutric Brunisol — Elevation: 5260 ft.

Horizon	Depth (cm)	Color Dry	Color Moist	Texture	Structure	Consistence
L - H	5-0					
Aej	0-10	light brownish gray to pale brown 10 YR 6/2-6/3	grayish brown 10 YR 5/2	SL	weak platy	very friable
Bm1	10-23	brown to pale brown 10 YR 5/3-6/3	brown 10 YR 4/3-5/3	L to CL	strong medium subang. blocky	friable
Bm2	23-52	yellowish brown 10 YR 5/4	brown to dark brown 10 YR 4/3	L to SCL	strong medium subang. blocky	friable
IIBC	52-73	pale brown 10 YR 6/3	dark grayish brown to brown 10 YR 4/2-4/3	CL	strong medium subang. blocky	firm
IIC	73-85+	gray to grayish brown 10 YR 6/1-5/2	dark gray 10 YR 4/1	SiCL	amorphous	firm

TABLE XXIV. ANALYTICAL CHARACTERISTICS OF THE DEGRADED EUTRIC BRUNISOL AT SITE 18

Horizon	Depth	pH	Tot. C	Tot. N	C/N Ratio	Exchange Analysis: Exch. Acid.	Na	K	Ca	Mg	T.E.C.	pH-Depend. C.E.C.	Free Fe_2O_3 Oxalate Fe	Oxalate Al	Citrate Fe	Citrate Al
	cm		%	%		%	%	%	%	%	me/100gms	%	%	%	%	%
L - H	5-0	6.1	34.8	2.04	n.d.	13	0	5	80	2	113.8	n.d.	n.d.	n.d.	n.d.	n.d.
Aej	0-10	5.4	1.9	.12	16	39	0	8	50	3	11.1	100	.06	.06	.58	.02
Bm1	10-23	5.0	.9	.07	13	28	0	4	59	9	11.9	99	.04	.06	n.d.	n.d.
Bm2	23-52	5.0	.9	.05	16	24	0	3	65	8	14.0	97	.04	.06	.66	.01
IIBC	52-73	5.1	1.0	.07	15	17	0	2	72	9	18.8	99	.05	.07	n.d.	n.d.
IIC	73-85+	7.1	n.d.	n.d.	n.d.	n.d.	n.d.	1	95	4	22.8	n.d.	.05	.05	.94	.01

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Spec. Grav.	Poros.	Moisture Analysis: Sat. Cap.	Sat. Cap.	1/3 Bars	1/3 Bars	15 Bars	15 Bars	A.W.C.	A.W.C.	Hygr.Moist.	Hygr.Moist.
	cm	%	%	%	%	%	gm/cc		%	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.
L - H	5-0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Aej	0-10	6	57	28	15	7	1.18	2.57	54.1	3.4	1.3	1.7	.7	.9	.4	.8	.3	.1	.1
Bm1	10-23	3	53	29	18	10	1.23	2.61	52.9	4.5	1.7	2.2	.9	1.2	.5	1.0	.4	.2	.1
Bm2	23-52	3	50	28	22	12	1.40	2.53	44.7	10.0	4.1	6.4	2.7	3.5	1.6	2.9	1.1	1.0	.4
IIBC	52-73	1	34	38	28	14	1.37	2.56	46.5	8.8	3.4	5.8	2.2	3.3	1.2	2.5	1.0	1.0	.4
IIC	73-85+	3	17	47	36	13	1.39	2.48	44.0	6.0	2.5	4.4	1.8	2.2	1.0	2.0	.8	.7	.3

calcium being the dominant cation on the exchange complex. Total carbon and oxalate-extractable sesquioxides generally decrease with increase in profile depth. Total clay content and exchange capacities increase with depth in the profile. The clay content in the B horizon meets the requirement for a Bt horizon.

Accumulation of clay and of citrate-extractable iron in the B horizons indicates that eluviation processes have taken place. Degradation of the Aej horizon is suggested by the diffraction pattern of the glycolated samples (Fig. 21). The 17 Å smectite peak on the diffractogram of the Aej horizon is broad and shouldered and weakly expressed as compared to that of the Bm2 horizon, indicating that weathering has taken place. The distribution of smectite in the solum suggest that illuvial clays are present in the B horizon. Presence of illuvial clay, a diagnostic Bt horizon, and the strongly acid pH of the solum excludes this soil from the Degraded Eutric Brunisol Subgroup of the Brunisolic Order (N.S.S.C., 1968). Similar results were reported by Pawluk, Peters and Carson (1967) for a Montane Degraded Brown soil of this physiographic region.

The morphological description and analytical results for the <u>Orthic Gray Luvisol</u> profile are presented in Tables XXV and XXVI. This soil is characterized by moderately acid pH values and a high base saturation. Accumulation of clay and sesquioxides is evident in the B horizons. Smectite clay is the dominant clay mineral in the solum (Fig. 22). This soil meets the criteria for the Orthic Gray Luvisol Subgroup within the Canadian System of Soil Classification (N.S.S.C., 1968). The characteristics of this soil are generally similar to those of Orthic Gray Luvisols in the Great Plains region of the Prairie Pro-

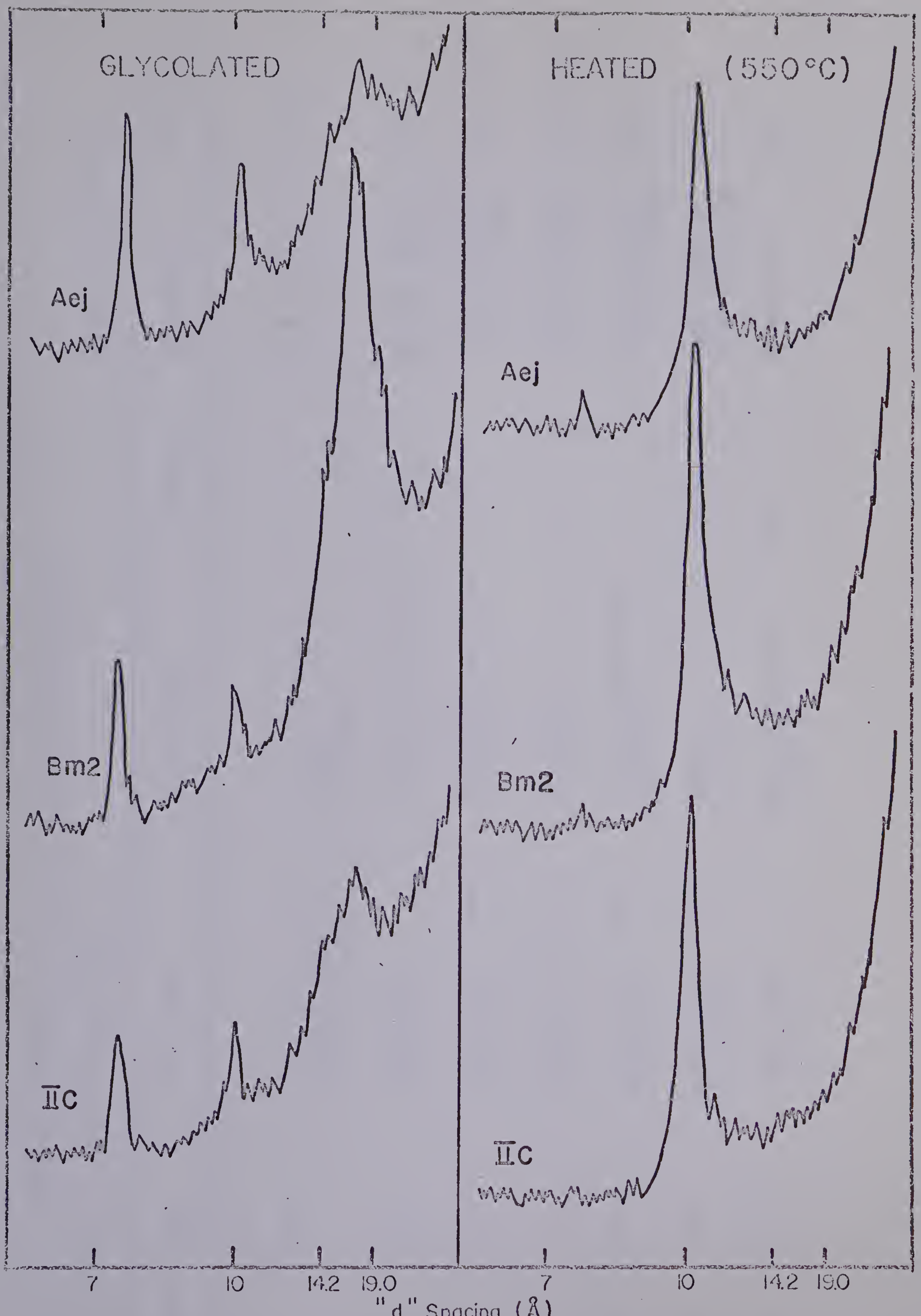


Figure 21. X-ray diffraction on patterns of the total clay fraction from the major horizons of the Degraded Eutric Brunisol profile.

TABLE XXV. PROFILE DESCRIPTION OF SITE 15 - STREETER CREEK BASIN

Classification: Orthic Gray Luvisol | Elevation: 4610 ft.

Horizon	Depth (cm)	Color Dry	Color Moist	Texture	Structure	Consistence
L - H	4-0					
Ae	0-10	light yell. gray to pale brown 10 YR 6/2-6/3	brown to dark brown 10 YR 4/3	L	weak platy	friable
IIAB	10-20	pale brown 10 YR 6/3	light brownish gray 10 YR 6/2	CL	strong fine subang. blocky	firm
IIBt1	20-42	light yell. brown 10 YR 6/4	dark grayish brown 10 YR 4/2	C	strong coarse subang. blocky	very firm
IIBt2	42-47	grayish brown 10 YR 5/2	dark gray 10 YR 4/1	C	strong coarse subang. blocky	very firm
IIBt3	47-74	light yell. brown 10 YR 6/4	dark grayish brown 10 YR 4/2	C	strong coarse subang. blocky	firm
IIIBC	74-96	light yell. brown 10 YR 6/4	brown 10 YR 4/3	SiCL	weak coarse subang. blocky	firm
IIIC	96-120+	pale brown 10 YR 6/3	grayish brown 10 YR 5/2	CL	amorphous	firm

TABLE XXVI. ANALYTICAL CHARACTERISTICS OF THE ORTHIC GRAY LUVISOL AT SITE 15

Horizon	Depth	pH	Tot. C	Tot. N	C/N Ratio	Exch. Acid.	Na	K	Ca	Mg	T.E.C.	pH-Depend. C.E.C.	Free Fe_2O_3 Oxalate Fe	Free Fe_2O_3 Oxalate Al	Free Fe_2O_3 Citrate Fe	Free Fe_2O_3 Citrate Al
	cm		%	%		%	%	%	%	%	me/100gms	%	%	%	%	%
L - H	4-0	6.8	34.1	1.64	n.d.	7	0	3	84	5	121.5	n.d.	n.d.	n.d.	n.d.	n.d.
Ae	0-10	6.2	1.5	.13	11	17	1	6	66	10	12.3	n.d.	n.d.	n.d.	.43	.01
IIAB	10-20	6.0	.9	.09	12	11	1	5	73	10	17.6	n.d.	n.d.	n.d.	n.d.	n.d.
IIBt1	20-42	5.3	.9	.08	12	12	1	3	75	9	25.7	n.d.	n.d.	n.d.	.70	.02
IIBt2	42-47	5.7	1.3	.07	18	7	0	3	78	12	33.1	n.d.	n.d.	n.d.	.94	.04
IIBt3	47-74	5.9	.6	.07	10	8	1	3	77	11	23.2	n.d.	n.d.	n.d.	n.d.	n.d.
IIIBC	74-96	7.1	1.8	.06	n.d.	n.d.	0	1	98	1	22.2	n.d.	n.d.	n.d.	n.d.	n.d.
IIIC	96-120+	7.6	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	.35	.01

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Spec. Grav.	Poros.	Moisture Analysis Sat.	Sat.	Cap. 1/3 Bars	1/3 Bars	15 Bars	15 Bars	A.W.C.	A.W.C.	Hygr.Moist.	Hygr.Moist.
	cm	%	%	%	%	%	gm/cc		%	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.
L - H	4-0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Ae	0-10	2	36	47	17	6	1.16	2.54	54.3	3.9	1.5	2.1	.8	.8	.3	1.3	.5	.1	.1
IIAB	10-20	6	21	44	35	18	1.37	2.57	46.7	4.3	1.7	3.0	1.2	1.5	.6	1.5	.6	.3	.1
IIBt1	20-42	1	20	34	46	24	1.47	2.54	42.1	11.6	4.7	7.7	3.2	6.0	2.1	1.7	.7	1.1	.5
IIBt2	42-47	2	5	28	67	36	1.40	2.55	45.1	3.3	1.3	2.1	.8	1.4	.5	.7	.3	.3	.1
IIBt3	47-74	0	31	33	36	19	1.53	2.60	41.2	14.4	5.9	8.4	3.4	5.3	2.2	3.1	1.2	1.3	.5
IIIBC	74-96	3	17	46	37	15	1.52	2.55	40.4	11.8	4.3	7.9	2.7	4.4	1.3	3.5	1.4	1.0	.4
IIIC	96-120+	11	28	43	29	8	1.64	2.60	36.9	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

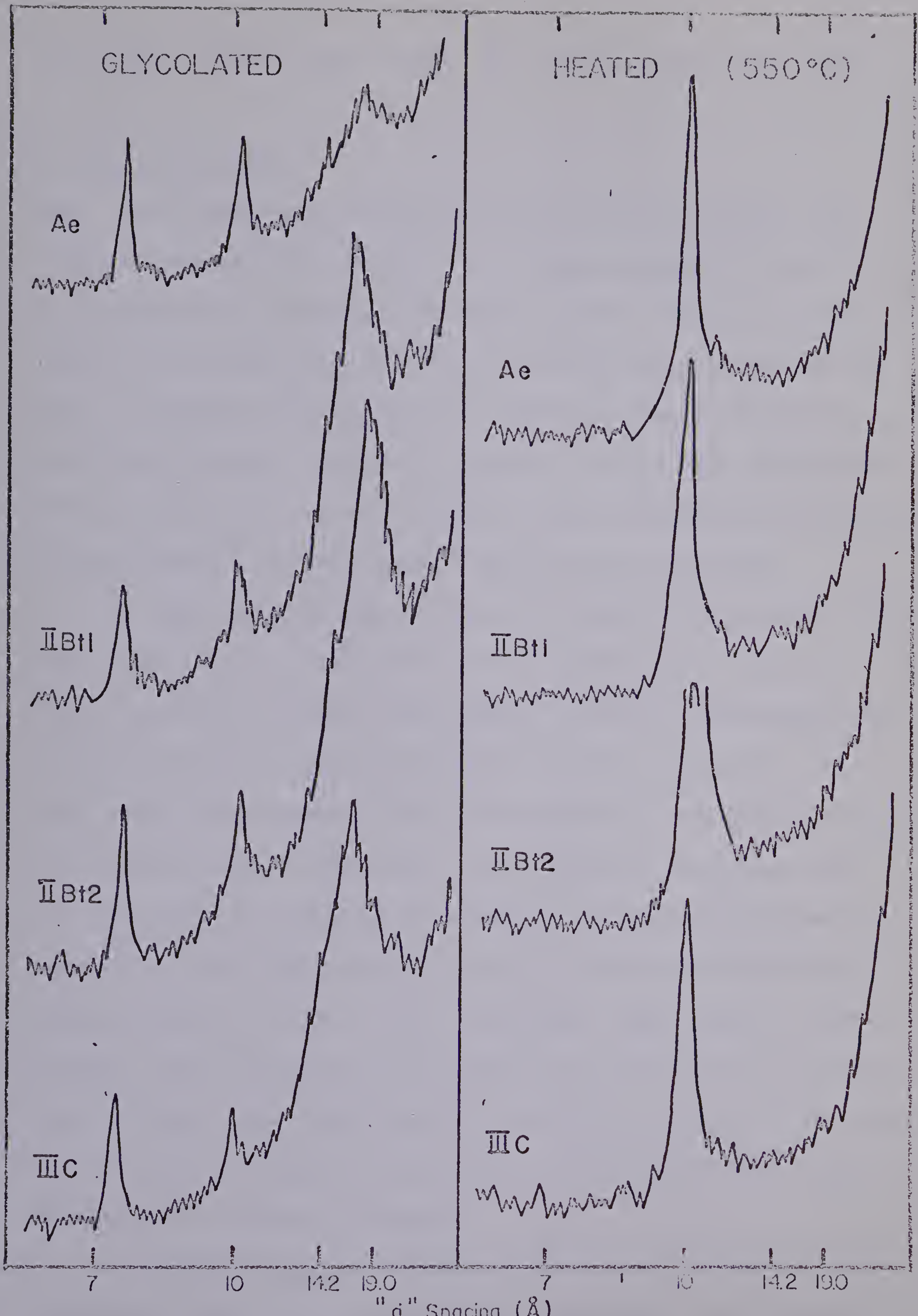


Figure 22. X-ray diffraction patterns of the total clay fraction from the major horizons of the Orthic Gray Luvisol profile.

vinces (Beke, 1964; Pawluk, 1961; St. Arnaud and Whiteside, 1964).

C: Deer Creek Basin

Land. Deer Creek Basin is characterized by steep topography, low effective precipitation, lodgepole pine (Pinus contorta) vegetation, and the presence of Quaternary surficial deposits. These surficial deposits are dominantly till and are derived from the Laurentide Ice Sheet. A mappable, glacio-lacustrine deposit occurs in the lower reaches of the basin. Postglacial deposits include both colluvial and alluvial materials. Colluvial deposits occur throughout the basin while alluvial deposits are encountered along the stream channels.

The Laurentide till deposits were found to be separable into three phases; namely, Till I, Till II A, and Till II B. The term Till I was used to indicate those deposits which are well comminuted. Such deposits are normally found in the southern, lower half of the basin along stream channels. Till II A designates very compact deposits, containing relatively few stones. It is generally associated with imperfectly drained soils and an understory of alder (Alnus, spp). vegetation. Till II B was the term used to distinguish less compact deposits similar to Till II A but containing a large amount of coarse skeleton. The II B phase of the Laurentide till deposits is generally found on slopes below bedrock highs. Both the II A and II B till phase have a neutral to slightly acid pH and are normally less than 5 feet thick above the midslope positions.

Glacio-lacustrine deposits are found near the lower boundary of the basin under mixed aspen-pine tree vegetation. These deposits are believed to be the result of the formation of a pro-glacial lake

in the Red Deer River Valley which adjoins the basin. The lacustrine deposits are generally stone free and have a strong to moderately acid pH. Buried soil profiles are present in these deposits.

Postglacial colluvial deposits are generally less than 1 foot thick and occur throughout the basin. Deep deposits were chiefly encountered in the West Deer Creek sub-basin (Fig. 23) on very steep, south- and east-facing slopes below rock outcrops. They are usually associated with grass or aspen vegetation. Although not delineated as a separate entity, a well-sorted colluvial deposit was encountered on the well-drained soils in the vicinity of the Main Stem and West Deer Creek confluence area. This material is usually associated with the comminuted till, which suggests that these two deposits reflect shallow laking conditions at an earlier time.

Alluvial deposits are found in the drainage channels. These deposits are characterized by sorted layers of coarse and finer sediments and the presence of buried soil horizons. In general, they contain a large amount of fine gravel.

Postglacial volcanic ash deposits were encountered in moderately sloping positions, but were generally too limited in extent for mapping purposes. Only one mappable area was present in the basin. The relatively pure ash from this location is expected to be of Mazama origin. Mixed ash and colluvial materials tend to be present in the upper horizons of well-drained Bisequa and Brunisolic Gray Luvisol soils.

Weathered shale layers were found as parent material in some imperfectly-drained soils at the higher basin elevations. These layers were underlain by slightly altered sandstone bedrock. Such shale layers

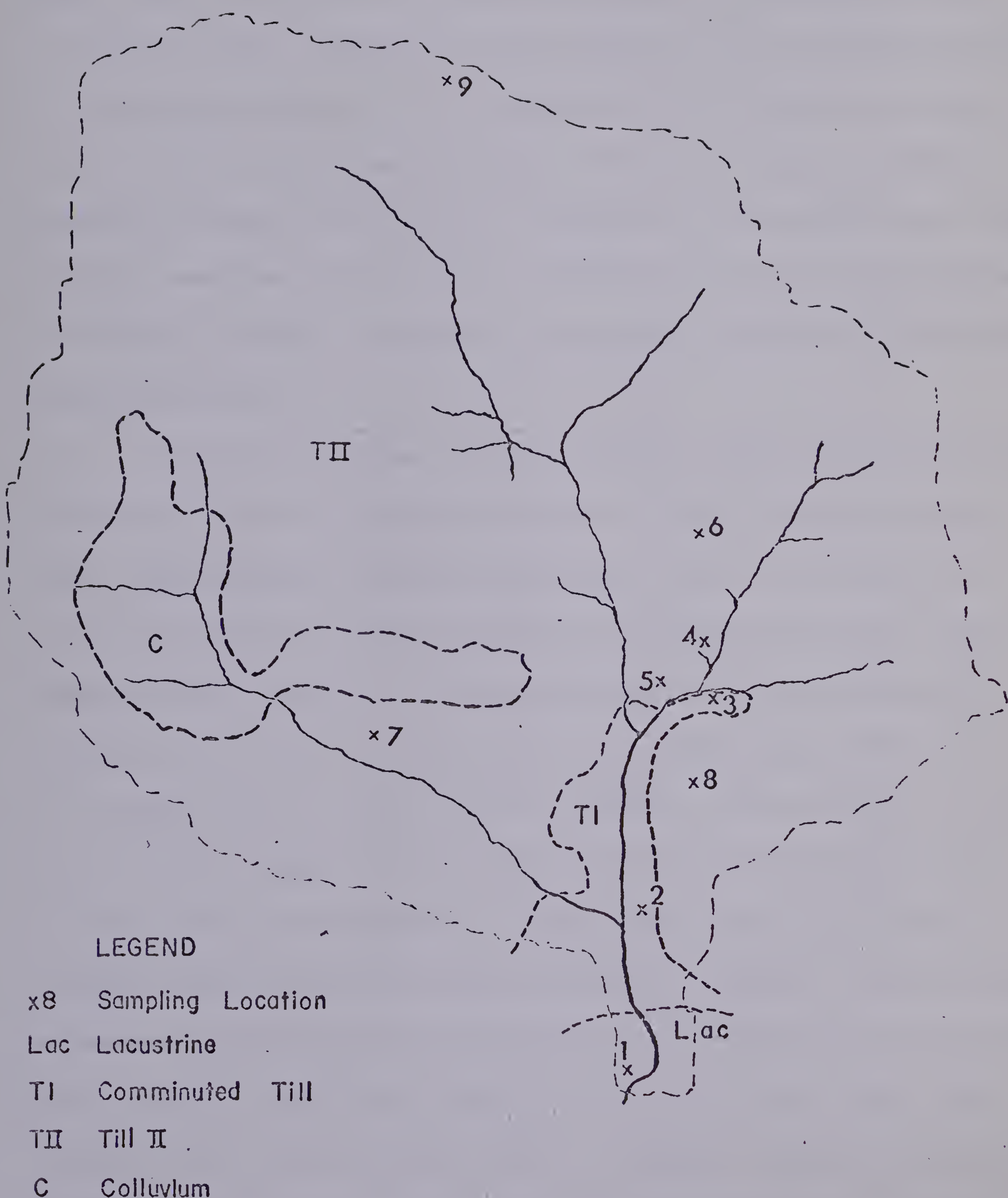


Figure 23. Sampling sites and distribution of parent materials in Deer Creek Basin.

are characterized by the absence of coarse skeleton and the presence of small shale fragments.

Soils. The distributions of soils in the basin are outlined on the enclosed soil map. Delineation of the soils is at the Subgroup level of abstraction according to the Canadian Soil Classification Scheme. A total of 18 soil subgroups are shown on the map, ranging from Terric Fibrisol to Bisequa Gray Luvisol. Locations of the mapping unit sampling sites are shown in Figure 23. Detailed morphological descriptions and analytical results for each of the sampled profiles are presented in Appendix III-B.

The soil map shows that Gray Luvisol soils are the principal soils in this basin. There is no evidence of soil zonation in the basin. Gray Luvisol (formerly Gray Wooded) soils in the basin are found in the moderately well and imperfectly-drained positions under lodgepole pine vegetation. Well-drained Brunisolic and Bisequa Gray Luvisols tend to occur in moderately to strongly sloping positions either at the ridge crests or near the valley bottoms. These soils are usually associated with mixed ash and colluvial deposits overlying the stony, till phase (Till II B) material. Orthic Gray Luvisols are found in locations where this mixed colluvial deposit is absent. Gleyed Orthic and Brunisolic Gray Luvisols are generally encountered below the mid-slope position. Dark Gray Luvisols were found on very steep, east-facing slopes. The presence of alder as dominant understory vegetation appeared to be associated with moderately well-drained Gray Luvisols on moderate slopes and with imperfectly drained Gray Luvisols on steep or very steep slopes having a thin colluvial deposit over till.

Eutric Brunisols in the basin belong chiefly to the Degraded Subgroup. The greater part of the Degraded Eutric Brunisols are well-drained and occur in the headwaters of the tributaries under mixed aspen and pine forest vegetation. In general, these soils are associated with steep to very steep slopes having relatively thick colluvial deposits.

Dystric Brunisols belonging to the Degraded Subgroup are found in the lower reaches of the basin. These soils are characterized by glacio lacustrine parent materials and moderate slopes, and occur under mixed-aspen-pine forest vegetation.

Black Chernozemic soils in the basin belong to the Rego Subgroup. These soils usually have a cumulic Ah horizon and are associated with grass vegetation. They are normally found near the drainage pathways on deep colluvial deposits.

Dark Gray Chernozems belonging to the Cumulic Rego Subgroup are delineated in only one location in the basin. These soils characteristically occur on steep southerly-facing slopes which have thick colluvial deposits. They are associated with aspen vegetation.

Regosolic soils encountered in the basin belong to the Orthic and Cumulic Subgroups and are of minor significance. Cumulic Regosols were encountered under aspen forest vegetation and appeared to occur in positions similar to the Rego Dark Gray Chernozems. Orthic Regosolic soils were separated into two Subgroup classes based on the presence or absence of a non-chernozemic Ah horizon. Both Classes tend to occur on the alluvial deposits in the drainage channels. They are normally found under grass vegetation.

Poorly drained soils present in the drainage pathways were classified as Fibrisols and Humic Gleysols. Usually they occur as the dominant member of a soil complex which includes Gleyed Eutric Brunisols. Soils belonging to the Terric Fibrisol Subgroup are characterized by moss vegetation while the Orthic and Rego Humic Gleysols tend to be associated with spruce (Picea glauca) forest vegetation.

The soil sampling sites selected to represent the variation in soil development are sites 1, 4, 5 and 9 (Fig. 23). The soils at these sites are discussed according to increasing degree of development. Arrangement of the sites according to degree of soil development is as follows: Cumulic Regosol (site 5), Cumulic Rego Black (site 4), Degraded Dystric Brunisol (site 1), and Orthic Gray Luvisol (site 9).

The morphological description and analytical results for the Cumulic Regosol profile are shown in Tables XXVII and XXVIII respectively. This soil has a neutral pH and is highly base saturated. Calcium is the dominant cation on the exchange complex. The mineral surface horizon has an organic matter content, C:N ratio, and morphological features that meet the requirements for a Chernozemic Ah, as defined by the National Soil Survey Committee (1968). The morphological features of this profile, together with the analytical characteristics, indicate very weak pedogenic development. X-ray diffraction results suggests that organic interlayering has taken place in the smectite clay of the Ahjl horizon (Fig. 24). The X-ray diffraction results do not reflect the observed lithological discontinuity in the solum. This indicates that the colluvial parent material is derived from deposits similar to the till underlying the colluvial material.

Plate 8. Photographs of soil profiles from Deer Creek Basin

Cumulic Rego Black (site D4)

Gleyed Eutric Brunisol (site D3)

Degraded Dystric Brunisol (site D1)

Orthic Gray Luvisol (site D9)

TABLE XXVII. PROFILE DESCRIPTION OF SITE 5 - DEER CREEK BASIN

Classification: Cumulic Regosol Elevation: 4750 ft.

Horizon	Depth (cm)	Color Dry	Color Moist	Texture	Structure	Consistence
L - H	2-0					
Ahj1	0-30	brown 10 YR 5/3	very dark grayish brown to d. brown 10 YR 3/2-3/3	SiCL	strong subang. blocky	friable
Ahj2	30-60	brown to pale brown 10 YR 5/3-6/3	dark brown 10 YR 3/3	SiL	weak prismatic to strong sub-ang. blocky	friable
IIBC	60-78	light brownish gray 10 YR 6/2	dark brown to dark grayish brown 10 YR 3/3-4/2	L	weak medium subang. blocky	friable
IIC	78-90+	pale brown to light gray 10 YR 6/3-7/2	dark grayish brown 10 YR 4/2	L to CL	amorphous	friable

TABLE XXVIII. ANALYTICAL CHARACTERISTICS OF THE CUMULIC REGOSOL AT SITE 5

Horizon	Depth	pH	Tot. C	Tot. N	C/N Ratio	Exchange Analysis: Exch. Acid.	Na	K	Ca	Mg	T.E.C.	pH-Depend. C.E.C.	Free Fe_2O_3: Oxalate Fe	Oxalate Al	Citrate Fe	Citrate Al
	cm		%	%		%	%	%	%	%	me/100gms	%	%	%	%	%
L - H	2-0	5.9	n.d.	n.d.	n.d.	15	0	4	81	0	110.9	n.d.	n.d.	n.d.	n.d.	n.d.
Ahj1	0-30	6.6	2.85	.20	14	6	0	2	83	10	27.5	n.d.	n.d.	n.d.	1.03	.03
Ahj2	30-60	6.9	1.56	.12	13	3	0	2	84	10	21.4	n.d.	n.d.	n.d.	.87	.02
IIBC	60-78	6.9	n.d.	.08	n.d.	2	0	1	88	8	21.2	n.d.	n.d.	n.d.	n.d.	n.d.
IIC	78-90	7.2	n.d.	n.d.	n.d.	0	0	1	89	10	19.9	n.d.	n.d.	n.d.	.87	.02

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Spec. Grav.	Poros.	Moisture Analysis: Sat. Cap.	Sat. Cap.	1/3 Bars	1/3 Bars	15 Bars	15 Bars	A.W.C.	A.W.C.	Hygr.Moist.	Hygr.Moist.
	cm	%	%	%	%	%	gm/cc		%	cm.	in.	cm.	in.	cm	in.	cm.	in.	cm.	in.
L - H	2-0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Ahj1	0-30	0	17	53	30	14	1.14	(2.65)	57.8	13.9	5.5	9.3	3.7	4.9	1.9	4.4	1.8	.5	.2
Ahj2	30-60	6	18	56	26	14	1.21	(2.65)	55.2	10.3	4.1	8.5	3.3	4.0	1.6	4.5	1.7	.4	.2
IIBC	60-78	17	32	44	24	6	1.19	(2.65)	56.0	6.0	2.4	4.1	1.6	2.0	.8	2.1	.8	.2	.1
IIC	78-90	9	29	44	27	9	1.19	(2.65)	56.0	3.9	1.5	3.0	1.2	1.5	.6	1.5	.6	.1	.04

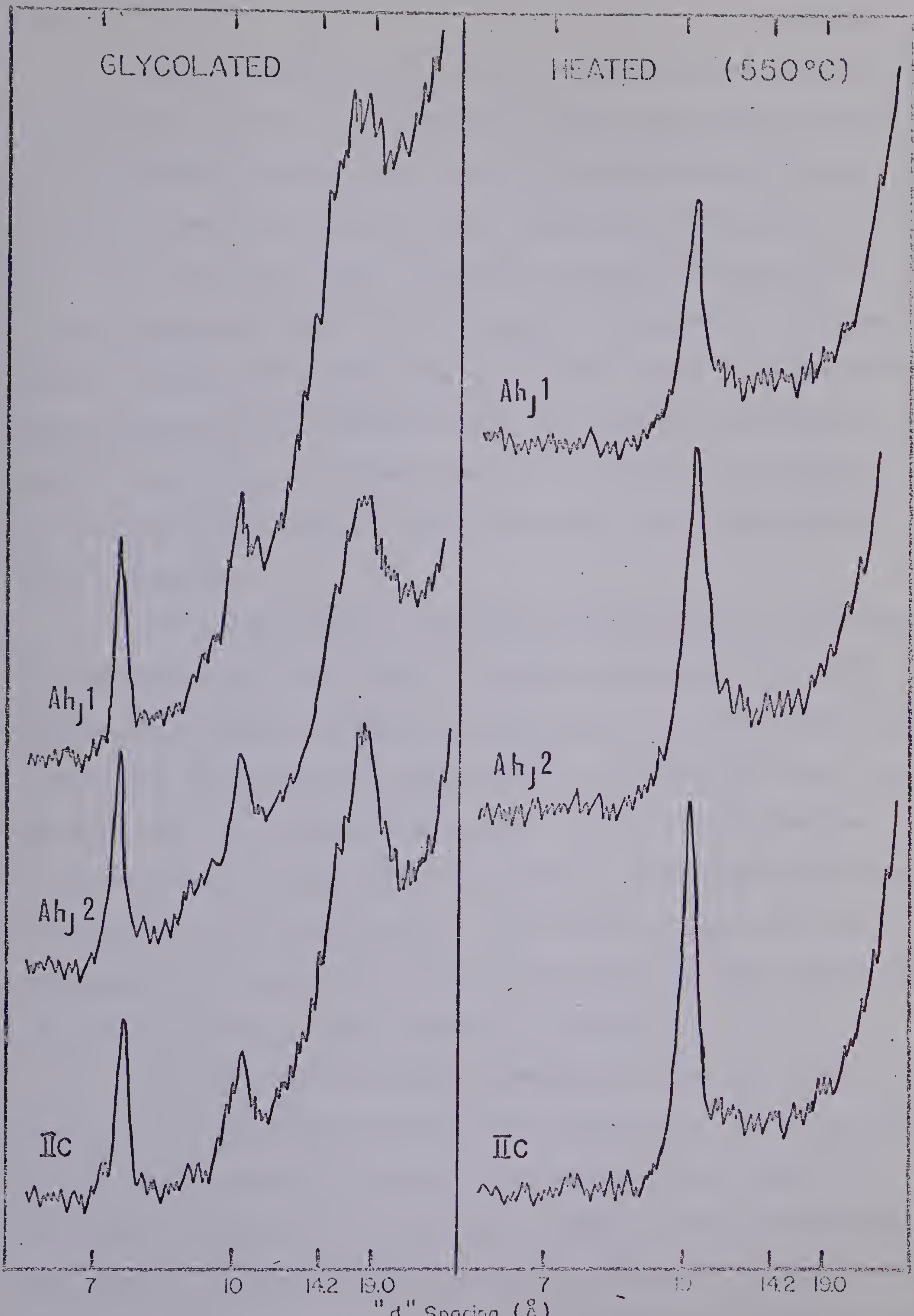


Figure 24. X-ray diffraction patterns of the total clay fraction from the major horizons of the Cumulic Regosol profile.

The designation of this soil as a Cumulic Regosol appears to be incorrect, although it is difficult to place in the Canadian System of Soil Classification (N.S.S.C., 1968). The morphological features of this soil meet the requirements for a Rego Brown Chernozem. However, this soil is associated with montane mesophytic vegetative and climatic conditions rather than with the xero-to mesophytic conditions typical for Brown Chernozems of the Great Plains region. Similar soils have been described by Duchaufour (1965) in Europe and are referred to as Sols bruns jeunes. Such soils are found on south-facing slopes in montane physiographic regions and are developed under "pelouse forêt mixte" vegetation.

The characteristics of the Cumulic Rego Black soil include an AC type of profile (Table XXIX) and high base saturation (Table XXX). Bulk density, exchange capacity, and C:N ratio values of the Ah1 horizon reflect its root-sod nature. Morphological and analytical results are suggestive of weak pedogenic development. This is supported by the X-ray diffraction results which indicate that organic interlayering has taken place in the smectite clay of the Ah2 horizon (Fig. 25). The similarity in the diffraction patterns of the major horizons support the observed uniformity of parent material in this soil.

This soil is not readily accommodated in the Rego Black subgroup of the Canadian Soil Classification System, when considering the characteristics of the Ah1 horizon. This horizon should perhaps be considered as part of the L-F horizon, in which case the soil would meet the criteria delineated for Rego Dark Brown Chernozems. However, the morphological characteristics of the Ah1 horizon are very similar to those of the Ah1 horizon in the Cumulic Regosol in Marmot Creek Basin (p.102).

TABLE XXIX. PROFILE DESCRIPTION OF SITE 4 - DEER CREEK BASIN

Classification: Cumulic Rego Black Elevation: 4850 ft.

Horizon	Depth (cm)	Color Dry	Color Moist	Texture	Structure	Consistence
L - F	2-0					
Ah1	0-9	black 10 YR 2/1	black 10 YR 2/1	SiL	strong, granular	very friable
Ah2	9-33	very dark grayish brown 10 YR 3/2	black to very dark brown 10 YR 2/1-2/2	SiCL	strong prismatic	friable
AC1	33-54	brown 10 YR 5/3	v.d. grayish brown to dark brown 10 YR 3/2-3/3	SiL	weak prismatic to strong sub.-ang. blocky	friable
AC2	54-78+	pale brown 10 YR 6/3	dark brown to dark grayish brown 10 YR 3/3-4/2	SiL	strong subang. blocky	firm

TABLE XXX. ANALYTICAL CHARACTERISTICS OF THE CUMULIC REGO BLACK AT SITE 4

Horizon	Depth	pH	Tot. C	Tot. N	C/N Ratio	Exchange Analysis						pH-Depend. C.E.C.	Free Fe_2O_3			
						Exch. Acid.	Na	K	Ca	Mg	T.E.C.		Oxalate		Citrate	
													Fe	Al	Fe	Al
	cm		%	%		%	%	%	%	%	me/100gms	%	%	%	%	%
L-F	2-0	7.2	n.d.	n.d.	n.d.	0	0	4	95	1	99.5	n.d.	n.d.	n.d.	n.d.	n.d.
Ah1	0-9	6.8	16.8	.55	31	5	0	1	89	5	83.9	n.d.	n.d.	n:d.	n.d.	n.d.
Ah2	9-33	7.0	4.1	.32	13	2	0	2	88	8	36.3	n.d.	.85	.02	n.d.	n.d.
AC1	33-54	6.8	2.2	.16	14	1	1	2	84	11	24.9	n.d.	n.d.	n.d.	n.d.	n.d.
AC2	54-78+	7.3	2.9	.10	n.d.	0	0	2	97	1	16.6	n.d.	.73	.01	n.d.	n.d.

Horizon	Depth	Mechanical Analysis					Bulk Dens.	Spec. Grav.	Poros.	Moisture Analysis									
		G	S	Si	C	FC				Sat. Cap.		1/3 Bars		15 Bars		A.W.C.		Hygr.Moist.	
	cm	%	%	%	%	%	gm/cc		%	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.
L-F	2-0	n.d.	n.d	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Ah1	0-9	0	23	52	25	8	.45	(2.65)	83.4	7.3	2.9	3.4	1.3	2.4	.9	1.0	.4	.1	.0
Ah2	9-33	5	18	54	28	10	1.07	(2.65)	60.4	13.7	5.4	8.5	3.3	4.1	1.6	4.4	1.7	.3	.1
AC1	33-54	7	21	53	26	10	1.17	(2.65)	56.7	9.4	3.7	6.4	2.5	3.0	1.2	3.4	1.3	.2	.1
AC2	54-78+	3	18	56	26	10	1.38	(2.65)	48.9	12.5	4.9	7.2	2.8	3.2	1.3	4.0	1.5	.3	.1

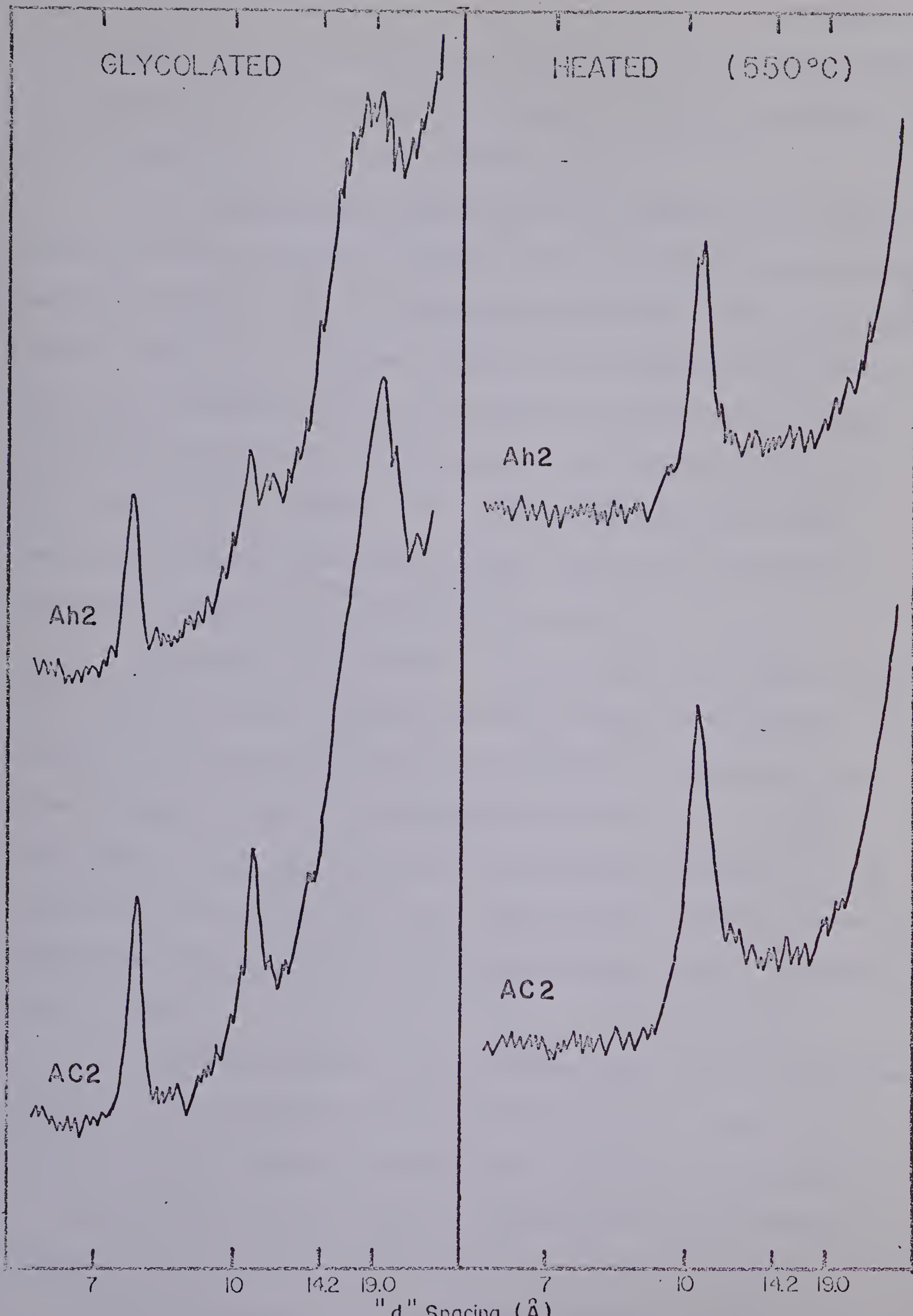


Figure 25. X-ray diffraction patterns of the total clay fraction from the major horizons of the Cumulic Rego Black profile.

This suggests the presence of a moder-type of humus, in which case this soil cannot be accommodated in the Chernozemic Order and is perhaps better classified as a Cumulic Regosol.

The Degraded Dystric Brunisol soil is characterized by weak horizon differentiation (Table XXXI), medium to strongly acid pH values, and base unsaturation as determined by unbuffered salt extraction (Table XXXII). Calcium is the dominant cation on the exchange complex of all horizons. Accumulation of oxalate-extractable sesquioxides is evident in the Btj horizon, but is insufficient to meet the requirements of a Bf horizon (N.S.S.C., 1968). This, together with the lack of clay accumulation suggests that the Btj horizon may best be described as a Bm horizon, despite its morphological expression.

The weak podzolic expression of this profile is supported by the results for cation exchange capacities and oxalate-extractable iron contents of the horizons in the solum. Oxalate-extractable iron contents are higher in the Aej and Btj horizons than in the C horizon. This suggests an in situ release due to weathering of minerals. X-ray diffraction results (Fig. 26) do not readily substantiate the observed degradation of the Aej horizon, although broadening of its 17 Å smectite peak is evident.

In general, smectite is the dominant clay mineral in the solum. Kaolinite clay is present in minor and illite in trace amounts. The characteristics of this soil generally meet the criteria established for Degraded Dystric Brunisols by the National Soil Survey Committee (1968).

The morphological description and analytical results for the Orthic Gray Luvisol profile are presented in Tables XXXIII and XXXIV,

TABLE XXXI. PROFILE DESCRIPTION OF SITE 1 - DEER CREEK BASIN

Classification: Degraded Dystric Brunisol — Elevation: 4510 ft.

Horizon	Depth (cm)	Color Dry	Color Moist	Texture	Structure	Consistence
L - H	5-0					
Aej	0-8	pale brown to light yellowish brown 10 YR 6/3-6/4	dark brown to brown 10 YR 3/3-4/3	SiL	weak platy	friable
Btj	8-17	brown to dark brown 10 YR 4/3	dark yellowish brown 10 YR 3/4	L	medium subang. blocky to med gran.	friable
C	17-62	dark brown to dark grayish brown 10 YR 3/3-4/2	very dark grayish brown 10 YR 3/2	CL	strong coarse granular	firm
IIAhb	62-67	v.d. grayish brown 10 YR 3/2	black 10 YR 2/1	CL	strong subang. blocky	friable
IIACb	67-73	d. grayish brown 10 YR 4/2	v.d. grayish brown 10 YR 3/2	CL to SiCL	amorphous	friable
IIC	73-85+	grayish brown to brown 10 YR 5/2-5/3	dark grayish brown grayish brown 10 YR 4/2-5/2	L	amorphous	friable

TABLE XXXII. ANALYTICAL CHARACTERISTICS OF THE DEGRADED DYSTRIC BRUNISOL

Horizon	Depth	pH	Tot. C	Tot. N	C/N Ratio	Exchange Analysis Exch. Acid.	Na	K	Ca	Mg	T.E.C.	pH-Depend. C.E.C.	Free Fe_2O_3 Oxalate Fe	Oxalate Al	Citrate Fe	Citrate Al
	cm		%	%		%	%	%	%	%	me/100gms	%	%	%	%	%
L-H	5-0	5.1	n.d.	n.d.	n.d.	37	0	3	60	0	77.1	n.d.	n.d.	n.d.	n.d.	n.d.
Aej	0-8	5.5	1.5	.11	14	23	1	2	65	5	18.4	87	.23	.11	.70	.01
Btj	8-17	5.4	1.0	.09	11	19	0	2	74	5	21.5	87	.33	.08	.89	.04
C	17-62	5.6	1.4	n.d.	n.d.	11	0	2	82	5	25.0	89	.18	.10	.92	.03
IIAhb	62-67	5.8	2.2	.18	12	11	0	1	84	3	28.9	n.d.	.13	.05	.82	.04
IIAC	67-73	5.9	1.4	.13	11	10	0	1	76	12	26.0	n.d.	.24	.05	n.d.	n.d.
IIC	73-85+	7.2	n.d.	n.d.	n.d.	0	0	1	99	0	21.4	n.d.	.02	.05	.67	.01

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Spec. Grav.	Poros.	Moisture Analysis Sat.	Cap.	1/3 Bars		15 Bars		A.W.C.		Hygr.Moist.	
	cm.	%	%	%	%	%	gm/cc		%	cm.	in.	cm.	in.	cm.	in.	cm.	in.	cm.	in.
L-H	5-0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Aej	0-8	0	29	52	19	6	.99	(2.65)	63.4	3.0	1.2	2.1	.8	.7	.3	1.4	.5	.1	.04
Btj	8-17	0	27	48	25	10	1.35	(2.65)	50.0	3.5	1.4	2.7	1.1	2.0	.8	.7	.3	.1	.04
C	17-62	0	24	47	29	13	1.18	(2.65)	56.3	16.5	6.5	13.8	5.4	6.3	2.5	7.5	2.9	.5	.2
IIAhb	62-67	0	27	45	28	11	1.14	(2.65)	57.8	2.0	.8	1.5	.6	.7	.3	.8	.3	.1	.04
IIAC	67-73	0	20	49	31	14	1.14	(2.65)	57.8	2.2	.9	1.9	.7	.9	.4	1.0	.3	.1	.04
IIC	73-85+	0	31	45	24	10	1.13	(2.65)	58.2	5.3	2.1	3.4	1.3	1.5	.6	1.9	.7	.1	.04

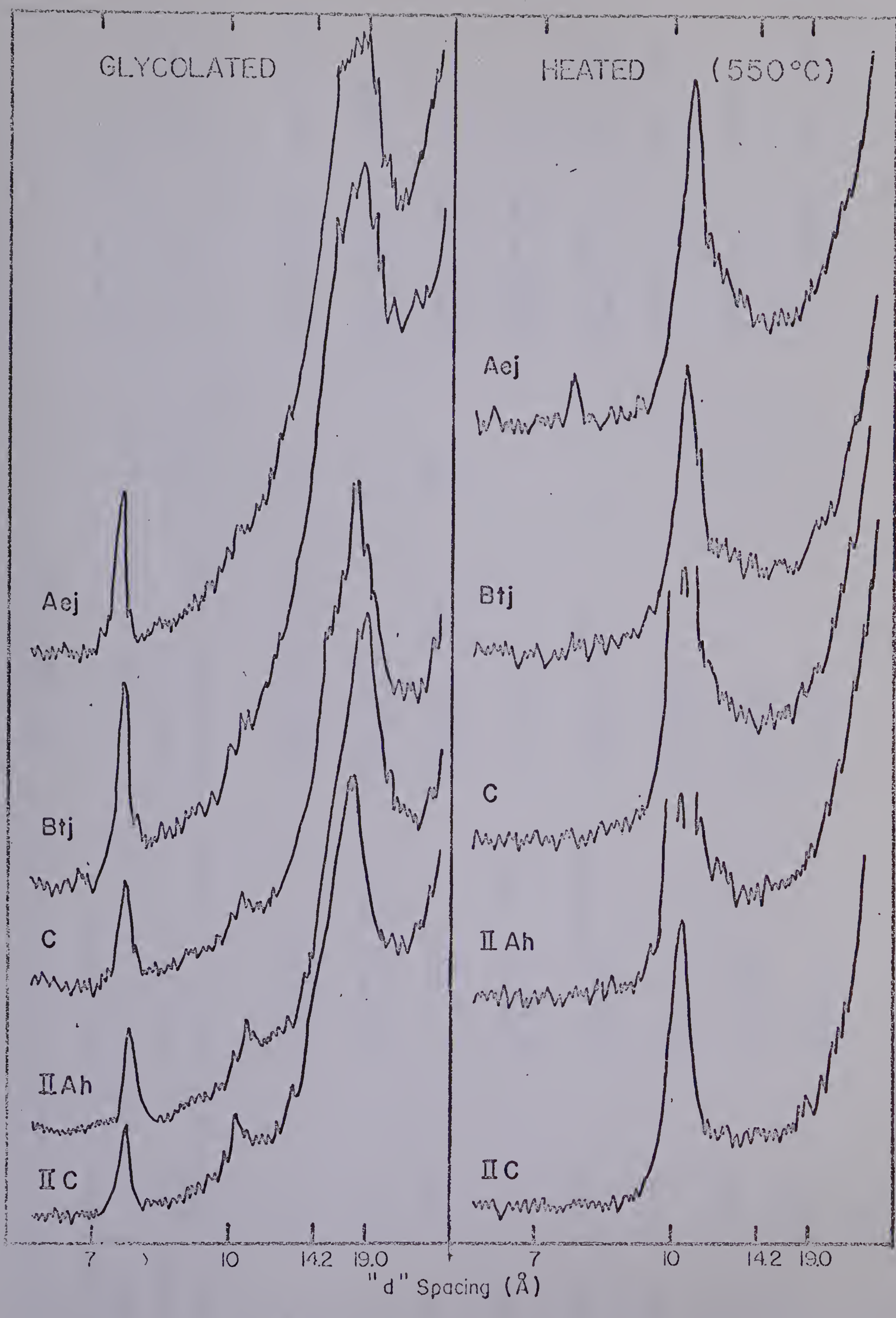


Figure 26. X-ray diffraction patterns of the total clay fraction from the horizons of the Degraded Dystric Brunisol profile.

TABLE XXXIII. PROFILE DESCRIPTION OF SITE 9 - DEER CREEK BASIN

Classification: Orthic Gray Luvisol Elevation: 5500 ft.

Horizon	Depth (cm)	Color Dry	Color Moist	Texture	Structure	Consistence
L - H	5-0					
Ae	0-5	light gray 10 YR 7/1	light brown. gray 10 YR 6/2	SiL	strong platy	very friable
AB	5-12	very pale brown 10 YR 7/3	pale brown 10 YR 6/3	L	weak subang. blocky	friable
IIBt1	12-29	pale brown 10 YR 6/3	yellowish brown 10 YR 5/4	SiCL	strong subang. blocky	firm
IIBt2	29-39	light yell. brown 10 YR 6/4	d. yellowish brown 10 YR 5/4	C	strong subang. blocky	firm
IIIBC	39-48	light brown. gray 10 YR 6/2	grayish brown 10 YR 5/2	C	weak subang. blocky	very firm
IIIC	48-62	gray 10 YR 5/1	dark gray 10 YR 4/1	C	amorphous	very firm
IVC	62-64	light yell. brown 10 YR 6/4	brown 10 YR 5/3	SiL	amorphous	friable
VC	64-68	brown 10 YR 5/3	dark brown 10 YR 3/3	L	single grained	very friable
R	68+					

TABLE XXXIV. ANALYTICAL CHARACTERISTICS OF THE ORTHIC GRAY LUVISOL AT SITE 9

Horizon	Depth cm	pH	Tot. C %	Tot. N %	C/N Ratio	Exchange Analysis: Exch. Acid. %	Na %	K %	Ca %	Mg %	T.E.C. me/100gms	pH-Depend. C.E.C. %	Free Fe_2O_3 Oxalate Fe %	Oxalate Al %	Citrate Fe %	Citrate Al %
L-H	5-0	3.9	n.d.	n.d.	n.d.	66	0	6	27	0	79.1	n.d.	n.d.	n.d.	n.d.	n.d.
Ae	0-5	4.5	1.0	.6	16	59	1	2	32	6	9.2	n.d.	n.d.	n.d.	.35	.00
AB	5-12	4.8	1.0	.8	13	40	1	2	47	10	15.2	90	.05	.09	n.d.	n.d.
IIBt1	12-29	4.4	.5	.6	9	30	0	2	59	9	21.8	98	.09	.10	1.31	.02
IIBt2	29-39	4.3	.6	.5	12	22	0	3	66	9	28.1	98	.14	.10	.98	.03
IIIBC	39-48	5.0	1.1	.5	22	10	0	2	77	11	31.1	97	.06	.05	n.d.	n.d.
IIIC	48-62	5.2	1.2	.0	n.d.	10	0	2	73	15	31.0	100	.08	.06	.76	.00
IVC	62-64	6.4	.9	.1	n.d.	3	0	2	89	6	30.6	100	.09	.07	n.d.	n.d.
VC	64-68	6.9	n.d.	n.d.	n.d.	3	1	1	84	11	12.4	100	.09	.09	.75	.02

Horizon	Depth cm	Mechanical Analysis G %	S %	Si %	C %	FC %	Bulk Dens. gm/cc	Spec. Grav.	Poros. %	Moisture Analysis: Sat. cm.	Cap. in.	1/3 Bars cm.	1/3 Bars in.	15 Bars cm.	15 Bars in.	A.W.C. cm.	A.W.C. in.	Hygr.Moist. cm.	Hygr.Moist. in.
L-H	5-0	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Ae	0-5	12	32	55	13	2	.91	(2.65)	66.3	1.3	.5	.9	.4	.2	.1	.7	.3	.0	.0
AB	5-12	16	29	48	23	6	1.35	(2.65)	n.d.	3.2	1.3	2.0	.8	1.2	.5	.8	.3	.1	.0
IIBt1	12-29	4	12	41	47	17	1.32	(2.65)	51.2	6.6	2.7	5.4	2.2	2.8	1.2	2.6	1.0	.2	.1
IIBt2	29-39	6	13	35	52	22	1.53	(2.65)	43.4	5.7	2.3	3.9	1.6	2.3	.9	1.6	.7	.2	.1
IIIBC	39-48	0	2	30	68	25	n.d.	(2.65)	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
IIIC	48-62	1	1	37	62	24	1.42	(2.65)	47.5	9.8	4.2	5.9	2.5	3.5	1.4	2.4	.9	.3	.1
IVC	62-64	2	12	68	20	6	n.d.	(2.65)	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
VC	64-68	n.d.	40	41	19	7	n.d.	(2.65)	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.

respectively. This soil is characterized by an extremely to very strongly acid pH, and a high exchange acidity in the upper horizons of the solum. Calcium is generally the dominant basic cation on the exchange complex. The soil is generally weakly base unsaturated when determined by neutral salt extraction. Accumulation of sesquioxides and clay is evident in the Bt horizons. Clay accumulation is largely the result of fine clay movement.

The base unsaturation, together with the low pH values, suggests that this soil has a high pH-dependent charge (Clark and Nichol, 1964). However, a high pH-dependent charge is characteristic of podzolic Bf horizons rather than the luvisolic Bt horizons (Clark, McKeague and Nichol, 1966; N.S.S.C., 1968). Such Bf horizons by definition must contain 0.8% more oxalate-extractable Fe + Al than the C horizon and between 0.5 and 5% organic matter. The Bt horizons of this Orthic Gray Luvisol meet the organic matter requirement for a Bf horizon but not the criterion for oxalate-extractable sesquioxide content. This indicates that the high pH-dependent charge in this soil cannot be explained by the presence of colloidal sesquioxide-organic matter complexes as is typical of most podzolic soils. An investigation for the presence of Mg-organic matter complexes may perhaps provide a better explanation.

The clay mineral composition of the Orthic Gray Luvisol soil consists dominantly of smectite clays (Fig. 27). Kaolinite and illite are present in minor amounts. Interstratification of 14 and 17 Å clays is evident on the diffractograms of the glycolated samples from the Ae horizon. This, together with the analytical results, reflects the podzolic degradation evident in the Ae horizons.

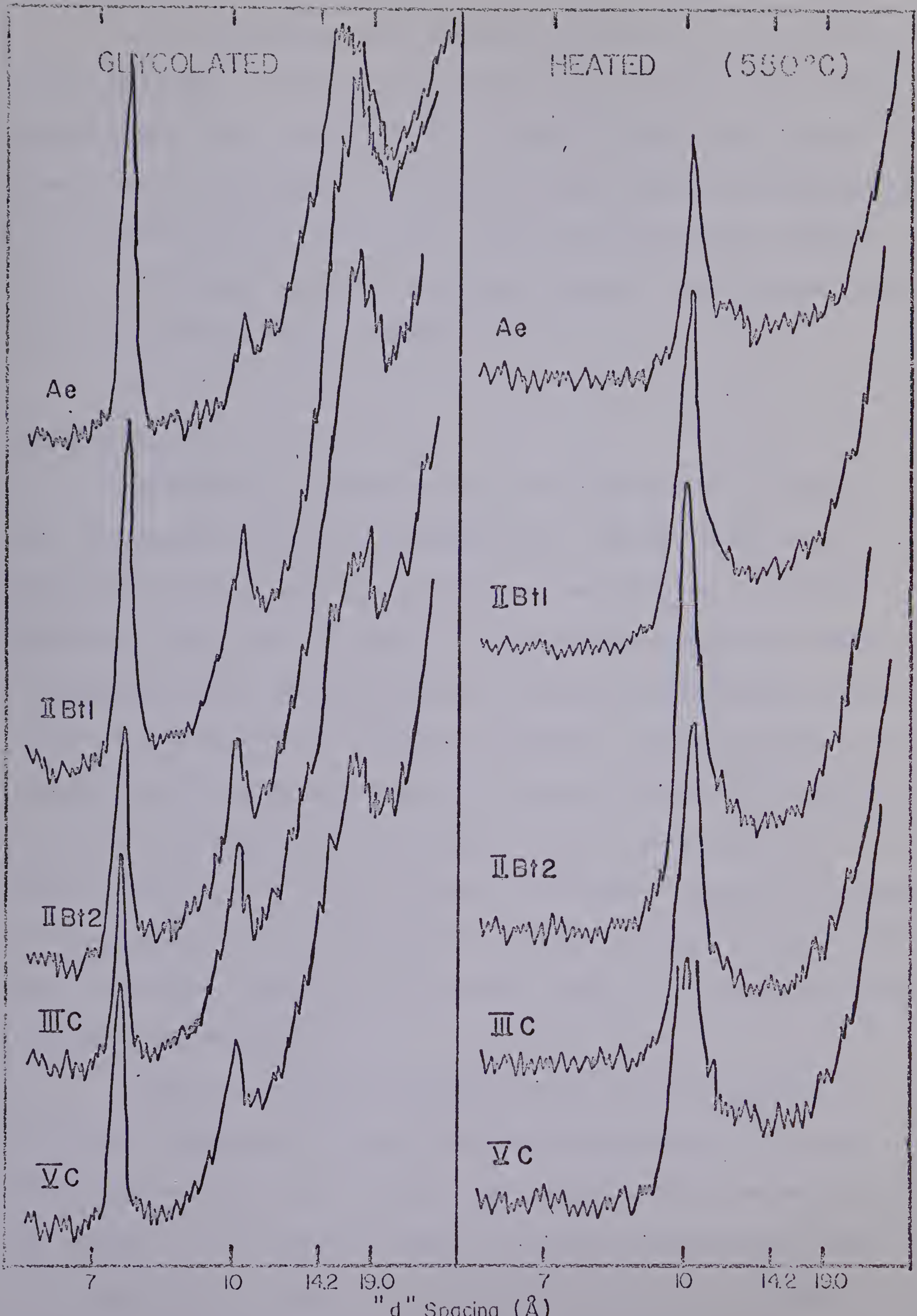


Figure 27. X-ray diffraction patterns of the total clay fraction from the dominant horizons of the Orthic Gray Luvisol profile.

The morphological and analytical properties of this soil are generally similar to those of Gray Luvisol soils from the Great Plains region (Beke, 1964; Pawluk, 1961; St. Arnaud and Whiteside, 1964). However, this soil differs by the lack of organic matter accumulation in the B horizon, the base unsaturation, and by the prominence of kaolinite in the solum. In general, this soil compares well with the Alcan series described by Pawluk (1961).

Computer Mapping

Alpha-numeric symbols present on the enclosed soil maps denote the computer code for the mapping units. Mapping units are representative of soil series, types, phases, and complexes. These are delineated on the basis of slope, internal drainage, nature and depth of organic horizons, nature and depth of postglacial surficial deposit, nature of parent material, and depth to bedrock. Descriptions of these variables according to mapping unit and computer code are presented in Appendix I-A, Appendix II-A, and Appendix III-A, respectively for Marmot Creek, Streeter Creek, and Deer Creek Basins. Computer compilation of areas representing a single mapping unit are included in the computer code description. Replicas of the computer maps of the basins are shown in Figures 28, 29, and 30.

The use of a computer mapping technique for compilation of soil survey information has apparently not been attempted previously. No attempt was made in this study to investigate the full potential of the program. It is apparent, however, that the codes employed in the three basins make it impossible to associate a particular code with specific soil types that may occur in all three basins. This limita-

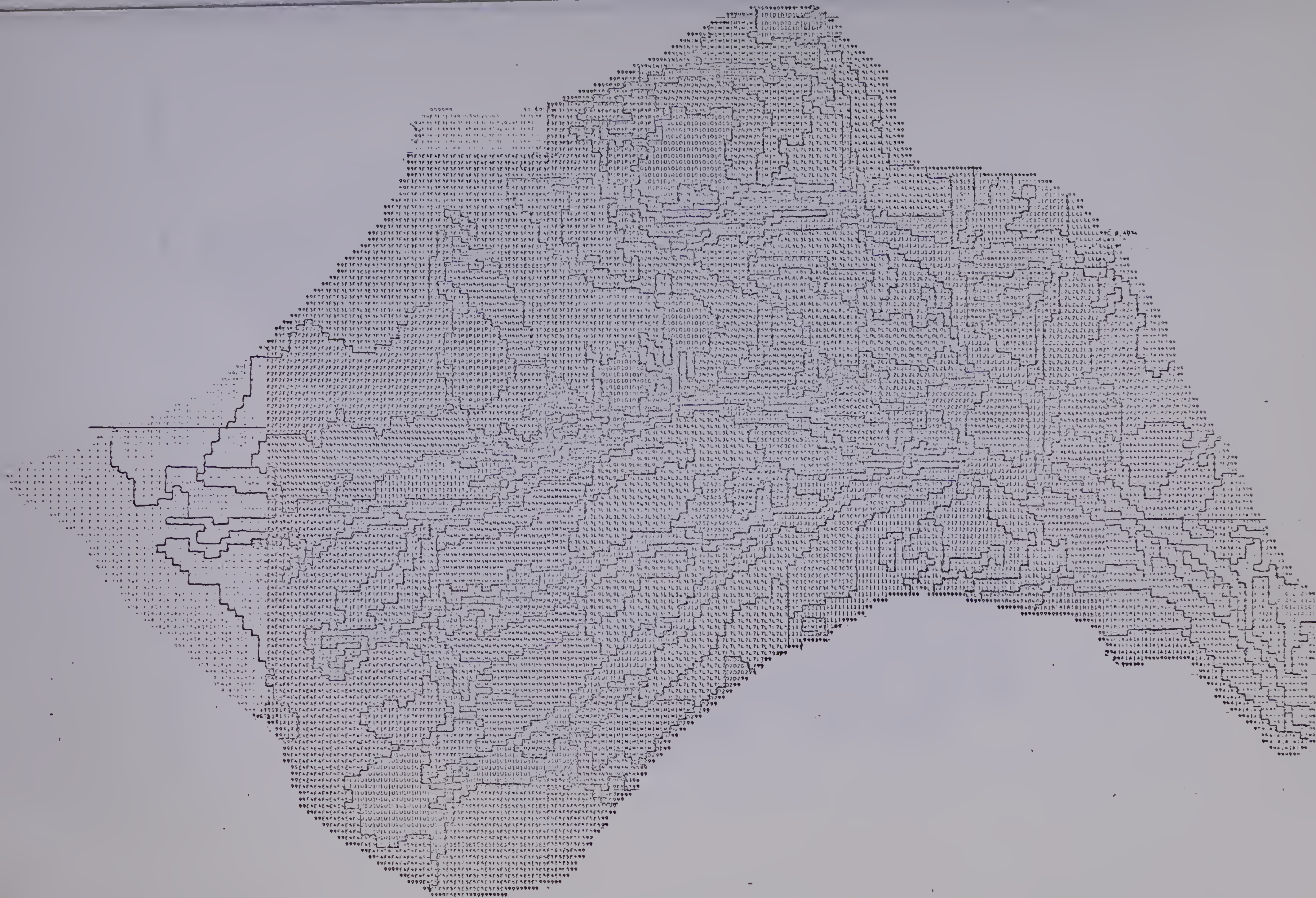


Figure 28. Computer map of the soils in Marmot Creek Basin.

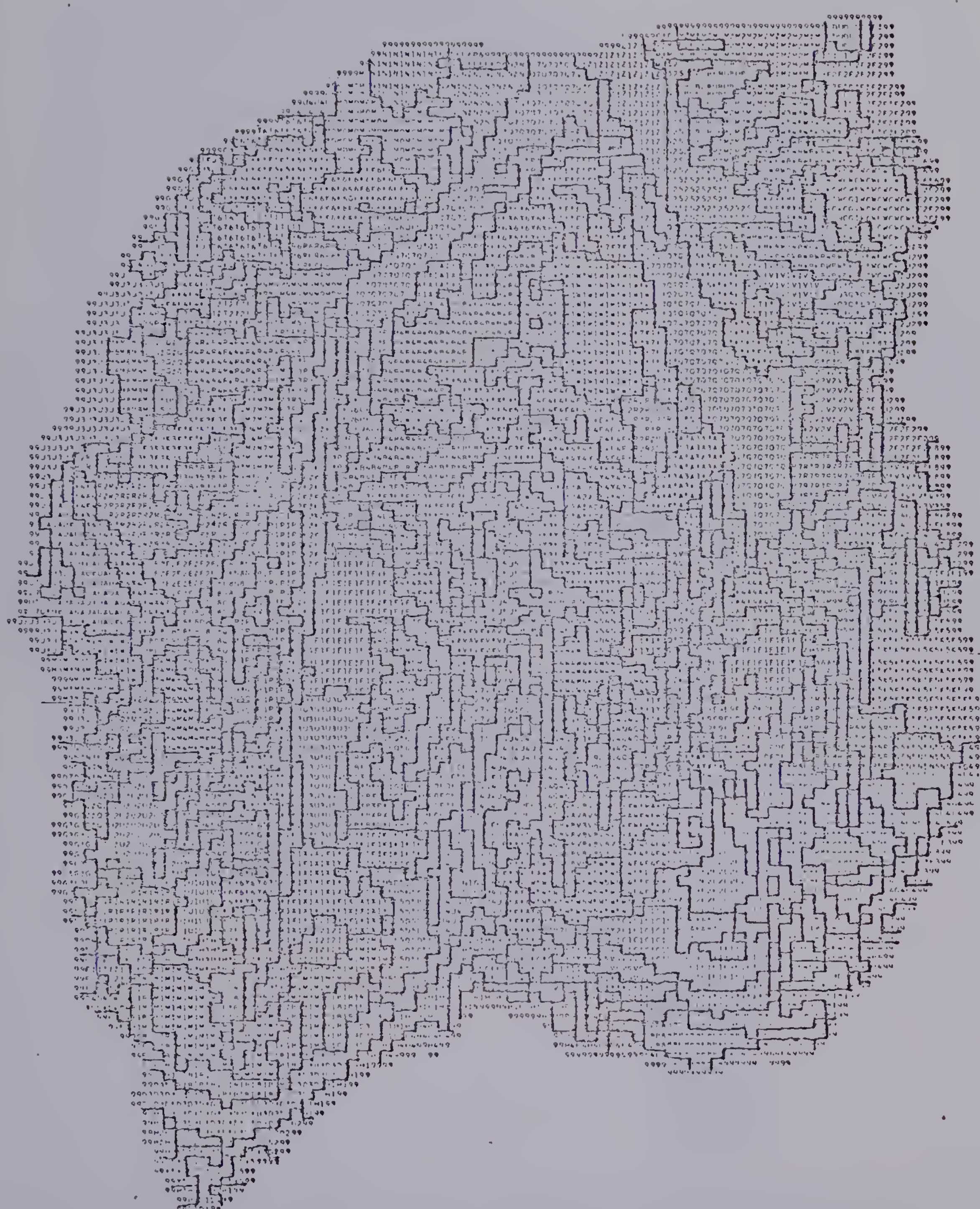


Figure 29. Computer map of the soils in Streeter Creek Basin.

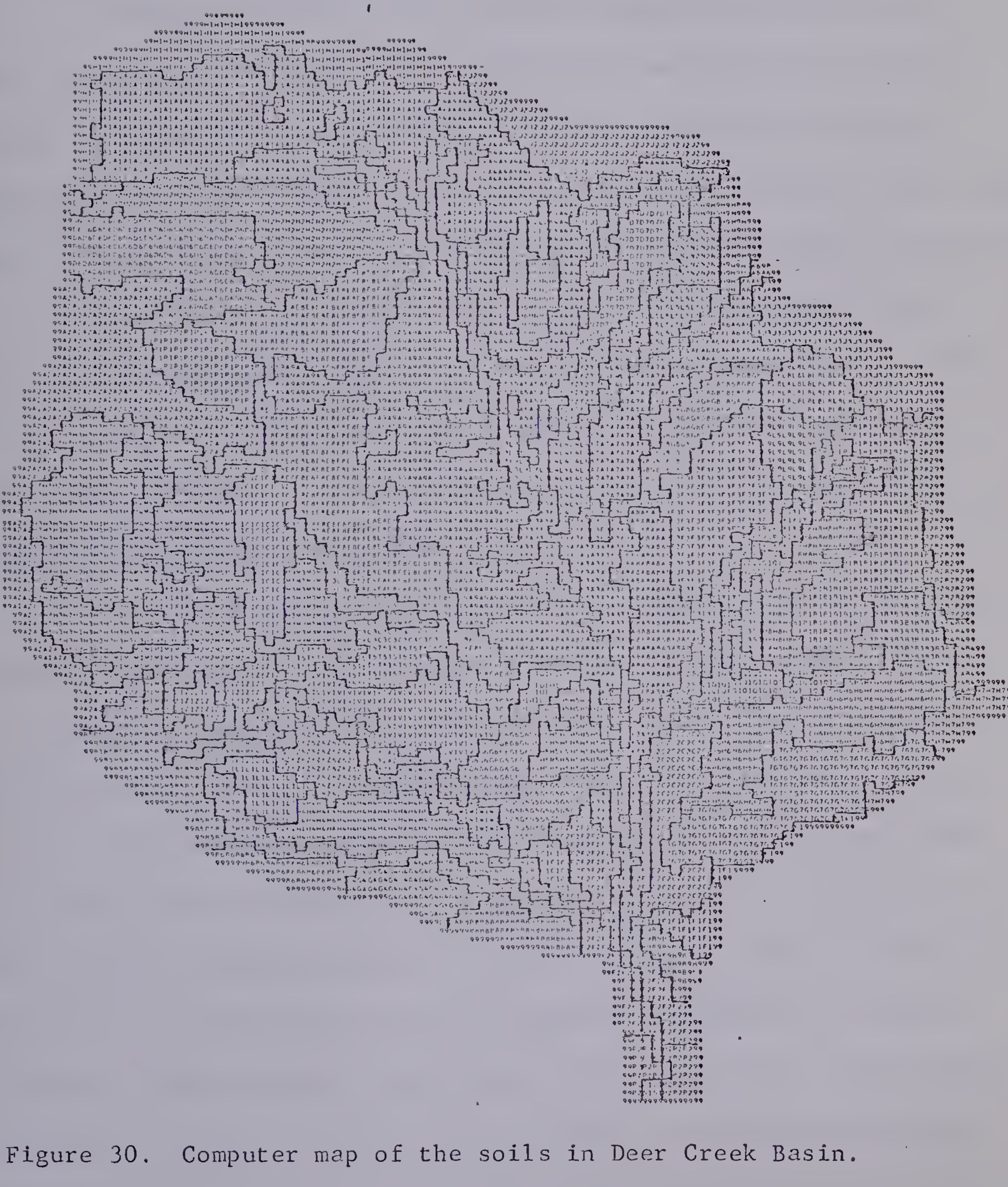


Figure 30. Computer map of the soils in Deer Creek Basin.

tion is inherent to the coding method of the program. Modification of the program could result in a coding system analogous to the soil classification coding system. Such a program would then be applicable to reconnaissance soil survey use on a national basis.

Computer mapping of soil survey information was generally found to be more practical than conventional cartographic procedures. Mapping by computer reduced the amount of time involved in the preparation of the final soil map by several months as a result of the elimination of preliminary maps. In addition, maps such as parent material or slope maps can be prepared by the computer from the input data. Also of time-saving significance is the concurrent compilation of the size of area representative of any specific mapping unit and of ratings, when specified. However, considerable time can be lost as a result of compiler system modifications.

The usefulness of the program also includes the delineation of any single mapping unit from the map-sheet as well as the option to combine two maps of a particular area into one. The latter aspect may prove very useful in interpretative soil classification. One of the most important aspects of computer mapping is the ease with which such a map can be up-dated. If, for instance, a forest fire causes alteration of soil characteristics over part of the map sheet, all that is required is a redefinition of the boundaries and codes of the area affected. Another example with similar work input would be the incorporation of a completed detailed survey into a reconnaissance survey map-sheet.

Hydrologic Soil Characteristics and Interpretive Classifications

Evaluations of hydrologic soil characteristics were obtained from site descriptions and from infiltration rate measurements, dispersion ratio, compressibility ratio, total storage capacity, and available water capacity determinations. These analyses were conducted in the field and the laboratory on soils which are representative of the mapping units. Compressibility ratios were obtained by dividing the bulk density of the surface mineral horizon by that of the source parent material. The presence of an impeding horizon within the 30 in. control section was designated on the basis of stratifications of the mechanical composition of the sola.

A: Marmot Creek Basin

Hydrologic soil characteristics. The hydrologic soil characteristics of the selected soils are presented in Table XXXV. Moisture capacity results show a relationship that can be equated to depth of the impeding horizon. Most of the selected soils have an impeding stratum within 12 inches of the mineral surface. The impeding stratum generally reflects an increase in clay content as a result of pedogenesis or of parent material stratification within the solum.

Dispersion ratios of the selected soils are generally greater than 10 per cent, which indicates that nearly all soils are erodible (Anderson, 1951). These ratios tend to correlate with the soils as classified at the Great Group level of abstraction within the classification scheme. Gray Luvisol and Gleysol soils generally have the higher dispersion ratio while Ferro-Humic Podzols and Eutric and Dystric Brunisols have the lower ratios.

TABLE XXXV. HYDROLOGIC CHARACTERISTICS OF SELECTED SOILS FROM MARMOT CREEK BASIN

Site	Soil Great Group	Depth to the impeding horizon or control section in.	Total Storage Capacity in.	Available Moisture Capacity in.	Minimum Infiltr. Rate cm/hr.	Dispers. Ratio %	Compress. Ratio	Slope %	Parent Material
M1	Gleysol	19	7.75	2.96	---	17.6	.88	7	C/C/Al/TI
M2	Gray Luvisol	15	---	---	---	15.9	---	42	A/TIC
M3	Gray Luvisol	4	1.53	.98	4.8	23.5	.94	9	RC/S
M13	Gray Luvisol	11	3.32	1.38	7.0	15.5	.80	9	C/TI
M19	Gray Luvisol	4	1.33	.61	9.0	19.5	.87	15	C/TIC
M35	Gray Luvisol	8	---	---	---	19.0	---	10	C/A/TI
M9	Ferro-Humic Podzol	7	---	1.77	8.0	15.4	.81	21	C/CA/A/TI
M12	Ferro-Humic Podzol	30	6.67	3.01	11.5	12.0	.86	6	A/TI
M15	Ferro-Humic Podzol	11	3.23	2.03	6.0	9.2	.79	18	C/A/TI
M16	Ferro-Humic Podzol	10	3.20	1.86	7.2	9.6	.76	21	C/A/TI
M8	Eutric Brunisol	30	4.82	1.68	---	16.4	.53	42	C/TI
M33	Eutric Brunisol	3	2.19	.86		11.4	.98	8	A/L/TI
M5	Dystric Brunisol	30	9.12	4.35	13.3	12.0	.80	9	TI
M10	Dystric Brunisol	10	2.59	1.53	.5	14.4	.98	18	C/C/TI
M14	Dystric Brunisol	30	10.24	4.88	---	16.6	.69	16	C/AC/TI
M25	Dystric Brunisol	30	7.91	3.10	17.8		.77	21	C/TII

C - Colluvium RC - Residual Colluvium L - Lacustrine

A - Aeolian CA - Mixed Aeolian and Colluvium T - Till

The results of the calculations for soil compressibility show that most soil surface horizons are quite densely packed. There are no apparent correlations between the compressibility ratios and soil or site characteristics. However, high total carbon content together with coarse textures tend to be associated with the more compressible horizons (Appendix I-B).

Mean minimum infiltration rates of the selected soils are generally higher than the maximum storm rainfall intensity reported for the basin (p.29). These rates appear to correlate with the nature of the soil parent material rather than with slope characteristics as suggested by Linsley, Kohler and Paulhus (1949). Soils with very low infiltration generally are associated with shale parent material or fine textured surface horizons (Appendix I-B). Soils developed in Till I parent material generally have a final infiltration rate between 6 to 10 cm/hour. Uniformity in the mechanical composition of the parent materials of theDystric Brunisol at site M5 and the Ferro-Humic Podzol at site M12 explains their higher than average rates. The infiltration rates at these sites approach that of the Dystric Brunisol at site M25, where the soil has developed in Till II material.

Mean infiltration rates for a number of profiles are shown in Figures 31 and 32. Soil saturation is generally attained within 30 minutes after the start of the experiment. Average initial infiltration rates vary considerably between soils. Such values generally serve as a poor basis for comparing soils in view of antecedent soil moisture content variations at the start of the individual measurements.

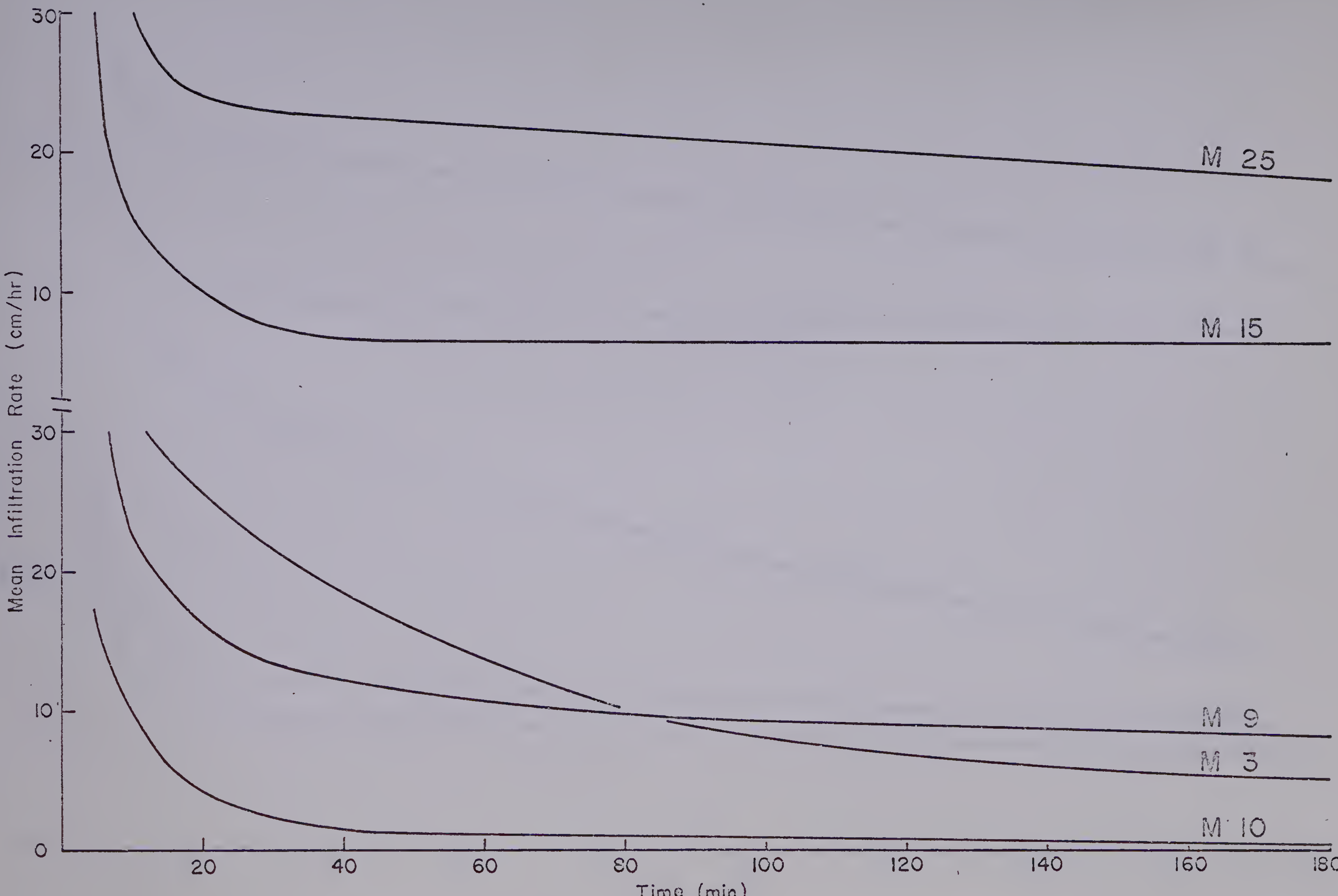


Figure 31. Mean infiltration rates of selected profiles from Marmot Creek Basin.

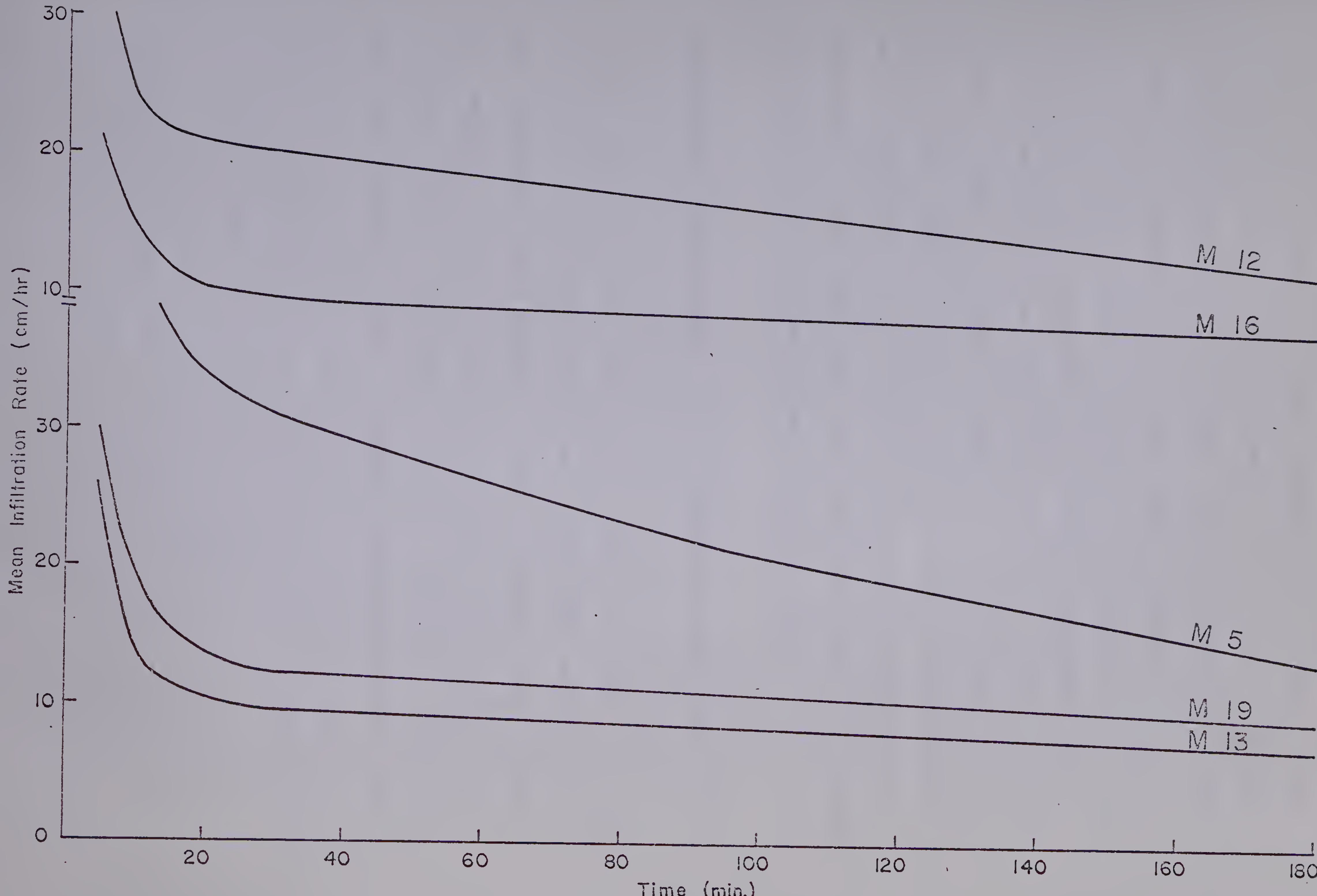


Figure 32. Mean infiltration rates of selected profiles from Marmot Creek Basin.

The replicate infiltration measurements performed at each site were found to be extremely variable. On the basis of analysis of pilot study results, Kramer (1968) outlined the magnitude of these variations and suggested that a large number of replicates were required in order to assign a representative infiltration rate to the mapping units. As a consequence, four replicate measurements were commonly made per sampling site which resulted in 16 infiltration rate curves per site. A preliminary multiple regression analysis, carried out by Kramer (1968) on the data, indicated that the slope variable was not significant for infiltration rates during the final hour of measurement. This suggests that the slope effect is lost due to stability of the subsurface flow which takes place on slopes.

Interpretive classifications. The hydrologic parameters selected for interpretive use are minimum infiltration rate, depth to impeding soil horizon, dispersion ratio, compressibility ratio, and slope. The range of values encountered for each parameter (Table XXXV) are grouped into four classes for rating purposes. Minimum infiltration rate classes are assigned as follows: soils in class A have a rate greater than 15 cm/hr., class B - 10-15 cm/hr., class C - 5-10 cm/hr., and class D - less than 5 cm/hour. Classes for depth to impeding horizon are 18-30 in. for class A, 12-18 in. for class B, 6-12 in. for class C, and 0-6 in. for class D. Slope class limits are from 0-15% for class A, 15-30% for class B, 30-60% for class C, and over 60% for class D.

The classes established for the hydrologic parameters are equated to the mapping units of the survey area. The suitability of the soils for water catchment is determined from the interaction

of the minimum infiltration rate class and the depth to the impeding horizon class. Thus, soils which are highly suitable for watershed management have a high minimal infiltration rate and the impeding horizon is at depth or entirely absent. The suitability map presented in Figure 33 shows that Alpine and Degraded Dystric Brunisols (Class B) soils are highly suitable for water catchment. Regosolic soils are generally moderately suitable. Gray Luvisols, Ferro-Humic Podzols and Degraded Dystric Brunisols (Class A) as well as the Eutric Brunisols are generally fairly suitable for watershed management.

Soil capability for water yield improvement is delineated on the basis of depth to impeding horizon and slope class interactions. The capability map presented in Figure 34 indicates that the capability of most soils in the upper forested region of the basin reflects their present suitability for water catchment. Steep slopes are the limiting factor for vegetation conversions on the soils. Programs for water yield improvement appear more fruitful for the lower half of the basin where slopes are less steep. No attempt was made to rate grassland soils for water yield improvement, because of insufficient information available on the suitability of different grass species for such purposes.

B: Streeter Creek Basin

Hydrologic soil characteristics. The hydrologic characteristics together with certain site characteristics of the selected soils are presented in Table XXXVI. Results for total and for available moisture storage capacity appear to relate well to the Great Soil Group level of abstraction within the Canadian System of Soil Classification.

Figure 33. Suitability of the soils in Marmot Creek Basin for water catchment.

Figure 34. Capability of the soils in Marmot Creek Basin for water yield improvement.

TABLE XXXVI. HYDROLOGIC CHARACTERISTICS OF SELECTED SOILS FROM STREETER CREEK BASIN

Site	Soil Great Group	Depth to the impeding horizon or control section in.	Total Storage Capacity in.	Available Moisture Capacity in.	Minimum Infiltr. Rate cm/hr	Dispers. Ratio %	Compress. Ratio	Slope %	Parent Material
S30	Humic Gleysol	30	12.37	4.04	---	18.8	.62	2-5	ALL/ALL
S23	Black Chernozem	20	6.20	1.93	5.81	13.5	.68	10-15	C/T
S25	Black Chernozem	17	7.49	2.41	5.81	13.6	.75	6-9	RES/R
S14	Black Chernozem	3	1.99	.28	1.87	14.6	.68	16-30	C/T
S24	Black Chernozem	12	5.25	1.03	2.76	12.8	.75	16-30	C/T
S19	Black Chernozem	23	11.10	1.97	3.83	30.2	.78	6-9	RES/R
S20	Black Chernozem	15	5.71	1.16	6.40	12.6	.75	30-60	RC/R
S1	Black Chernozem	25	8.57	2.20	----	2.07	.58	16-30	C/MTI/T
S29	Black Chernozem	30	12.59	3.06	4.64	11.3	.78	2-5	ALL/T
S26	Black Chernozem	30	14.28	4.10	10.66	26.9	.72	2-5	ALL/ALL
S28	Black Chernozem	25	12.03	2.45	17.70	25.6	.74	16-30	ALL/T
S2	Black Chernozem	30	12.15	3.82	----	4.7	.68	16-30	C/MTI
S13	Black Chernozem	30	17.66	2.96	4.77	13.2	.76	16-30	ALL/T
S21	Dark Gray Chernozem	30	9.42	2.29	16.71	16.1	.89	30-60	RC
S18	Eutric Brunisol	9	3.11	.72	----	8.8	.91	10-15	RC/MTII
S17	Gray Luvisol	5	2.46	.46	19.71	4.5	.87	16-30	C/MTI
S22	Gray Luvisol	11	4.05	1.28	6.62	3.7	.86	16-30	RC/MTII
S15	Gray Luvisol	4	1.95	.51	----	10.1	.89	16-30	C/MTI
S27	Gray Luvisol	8	2.67	.78	----	11.8	.75	16-30	C/MTI

Legend:

All - Alluvium
C - Colluvium
RC - Residual Colluvium
RES - Residual
R - Rock
T - Till
MTI - Mixed Till I
MTII - Mixed Till II

Eutric Brunisols and Gray Luvisols generally have the lowest moisture capacities as a result of impeding textural horizons (Appendix II-B) close to the land surface. Thick and Cumulic Chernozemic soils generally have a very high moisture storage capacity due to the high organic matter content and the absence of an impeding horizon within the control section.

Four total storage and four available moisture capacity classes can be delineated for grouping of soils in the basin. Classes for total storage capacity are class A for soils having over 12 in. total storage capacity, class B soils having 8-12 in., class C soils having 4-8 in., and class D for soils having less than 4 in. total storage capacity. Available moisture capacity classes range from 0-1 in. for class D soils to more than 3 in. for soils in class A. These classes are generally established on the basis of Soil Subgroup classification, vegetation type, and parent material type.

Dispersion ratio and compressibility ratio also appear to be related to the Great Soil Group level of abstraction of the classification system. In general, soils with an eluviated horizon are non-erodible and highly compacted. Soils with organic matter accumulation are usually highly erodible and less compacted. The soils can be grouped into dispersion and compressibility classes according to soil Subgroup classification, vegetation type and postglacial colluvium deposit considerations. Soils groupings for erodibility correspond to the following dispersion ratio classes: class A has a very low erosion probability of less than 6, class B from 6-12, class C from 12-18 and class D has a very high probability of over 18. Compressibility ratio classes range from 1-.85 for poorly compressible horizons

to less than .65 for highly compressible horizons.

Mean minimum infiltration rates of the selected soils are generally higher than the maximum storm rainfall intensity reported for the basin (p.33). These rates are chiefly related to parent material characteristics. Soils with very low minimum infiltration rates are generally associated with thin colluvial deposits overlying (Laurentide) till on which grass vegetation is established. High rates are associated with thick colluvial deposits and forest vegetation. The ranges of the infiltration rate classes delineated for soils in the basin are: class A, greater than 15 cm/hr., class B, from 10 to 15 cm/hr., class C, from 5 to 10 cm/hr., and class D, has a rate of less than 5 cm/hour.

The minimum infiltration rate data presented in Table XXXVI were obtained from the results of a study by Singh (1969). The rates reported represent the average rate of four replicate measurements by the concentric ring method (Katchinsky, 1936). Duplicate measurements were made at a few sites to compare these results with those obtained by Kohnke's (1938) method of infiltration measurements (Fig. 35). Results obtained by both methods compare favourably at the class level delineated for the infiltration rate parameter. It is also evident from Figure 35 that the soils in the basin become saturated within 30 min. of the start of the experiment.

Interpretive classifications. The hydrologic parameters selected for interpretive use in the basin are minimum infiltration rate, total storage capacity, available moisture storage capacity, dispersion ratio and compressibility ratio. These parameters are equated to the mapping

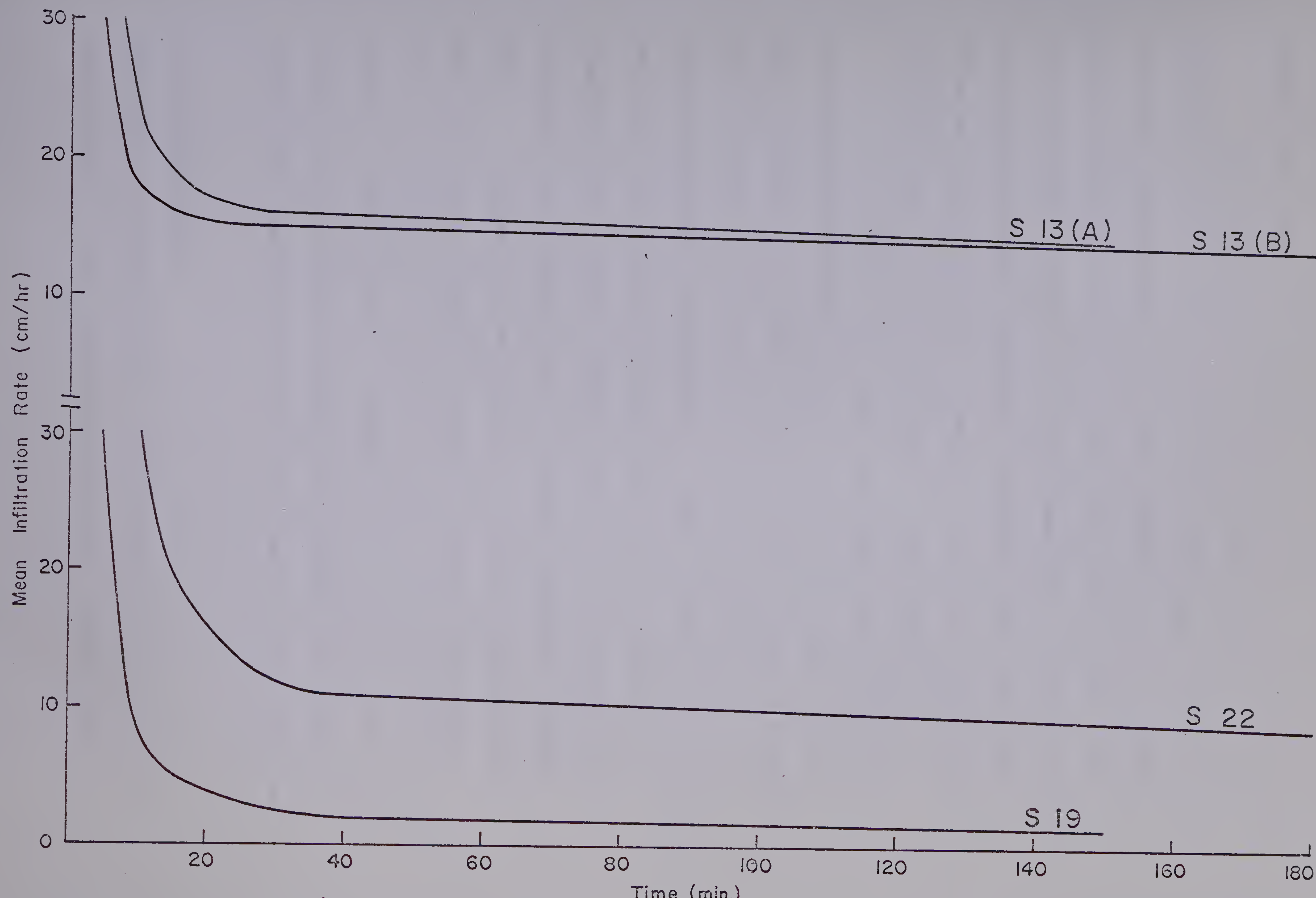


Figure 35. Mean infiltration rates of selected profiles from Streeter Creek Basin.

units of the survey area according to the classes previously outlined.

The suitability of the soils for water catchment is determined from the interaction of the minimum infiltration rate class and the total storage capacity class. The suitability map presented in Figure 36 shows that the greater part of the basin contains soils which are fairly suitable for watershed management. Chernozemic soils occurring under forest vegetation are generally better suited than those under grass vegetation. Gray Luvisol soils are usually among the least suitable soils of the basin for water catchment.

Soil capability for water yield improvement is delineated on the basis of available moisture capacity class, slope class, and depth to bedrock. Grassland soils are not rated because of insufficient information available on grass species suitability for water yield improvement. The capability map (Fig. 37) indicates that most soils under forest would not improve water yield on conversion of vegetation. This result is rather startling when considering that available water capacity rather than slope is usually the limiting factor. It appears that available water capacity is an unfortunate choice for use as an hydrologic parameter because of the dynamic effect of continuous incorporation of organic matter on available water capacity. Perhaps 'potential' available water capacity could be used in place of available water capacity, by estimating the increase in organic matter content which would result from vegetation conversion.

C: Deer Creek Basin

Hydrologic soil characteristics. The hydrological and certain site characteristics of the selected soils are shown in Table XXXVII.

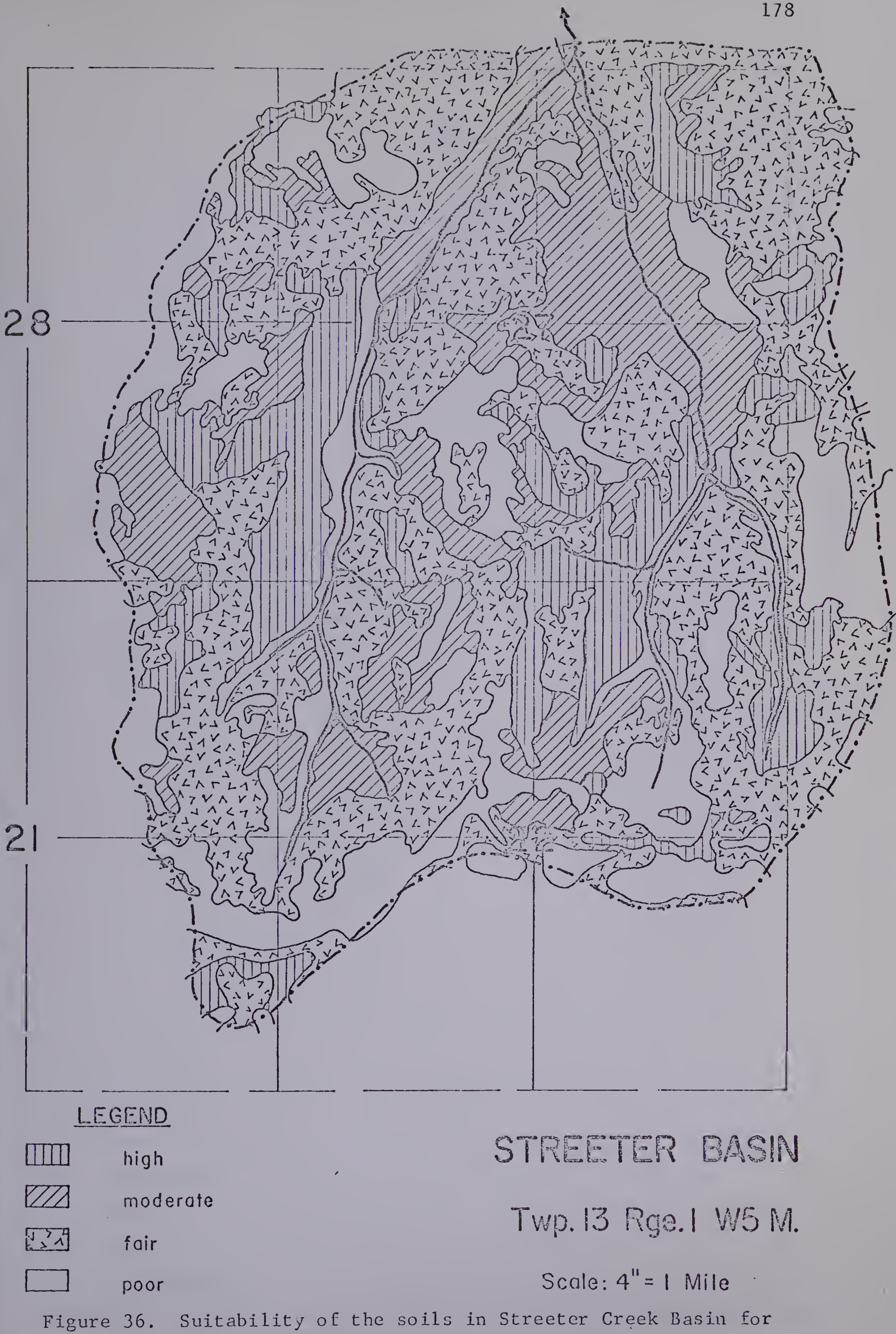


Figure 36. Suitability of the soils in Streeter Creek Basin for water catchment.

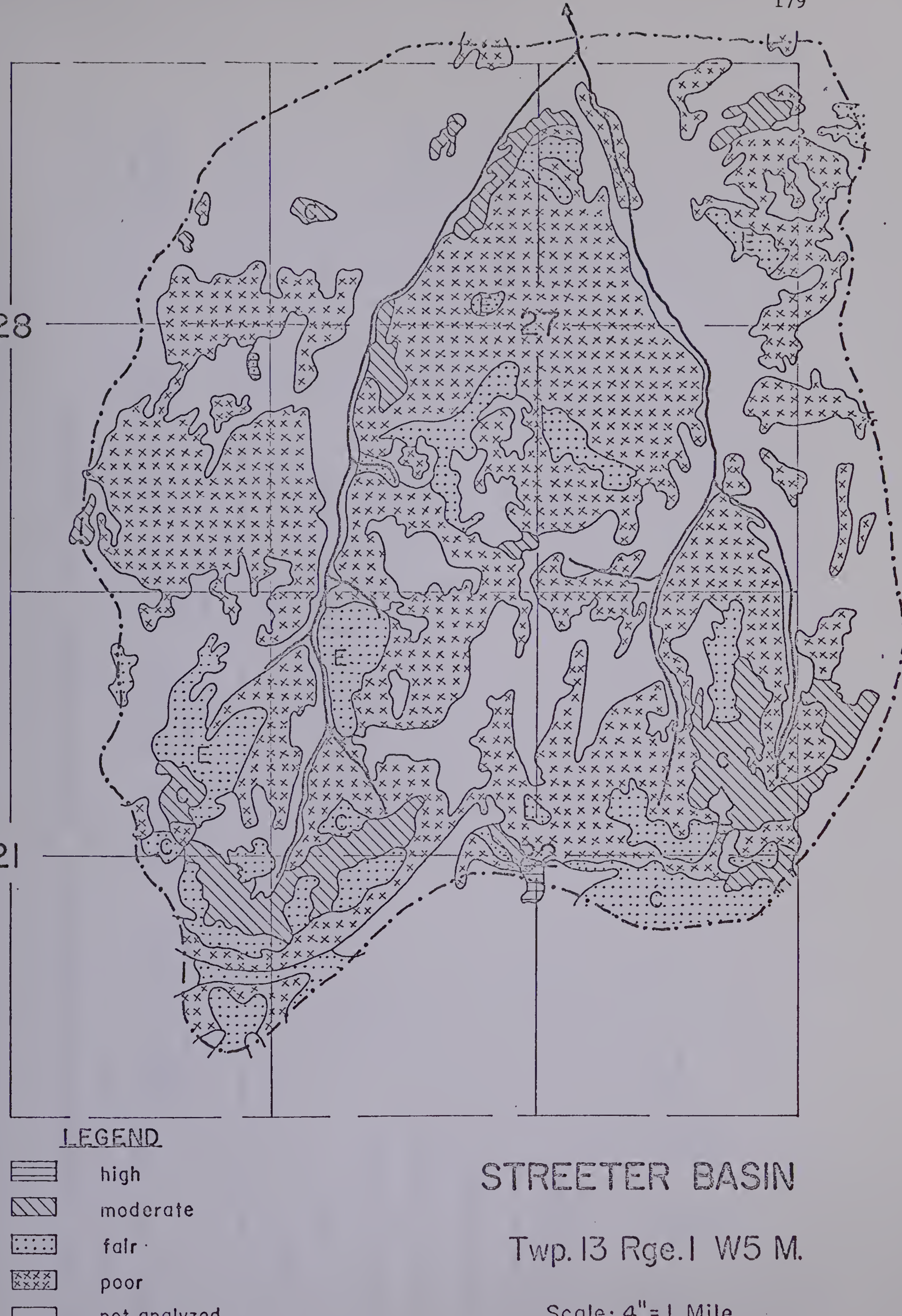


Figure 37. Capability of the soils in Streeter Creek Basin for water yield improvement.

TABLE XXXVII. HYDROLOGIC CHARACTERISTICS OF SELECTED SOILS FROM DEER CREEK BASIN

Site	Soil Great Group	Depth to the impeding horizon or control section in.	Total Storage Capacity in.	Available Moisture Capacity in.	Minimum Infiltr. Rate cm/hr.	Dispers. Ratio %	Compress. Ratio	Slope %	Parent Material
D5	Regosol	30	12.0	4.3	1.0	4.8	.96	10-15	C/TI
D4	Rego Black	30	16.9	4.9	n.d.	13.7	.38	10-15	C
D3	Eutric Brunisol	30	11.6	5.6	n.d.	5.4	.86	6-9	TI
D1	Dystric Brunisol	30	10.8	4.3	14.5	11.5	.88	6-9	Lac/Lac
D2	Gray Luvisol	5	2.2	1.1	4.0	13.0	n.d.	10-15	C/TI
D8	Gray Luvisol	6	1.9	.7	9.0	37.9	.63	16-30	C/TIIB
D9	Gray Luvisol	5	1.6	.6	5.8	11.7	.67	6-9	C/TIIA/Sh

Legend: C - Colluvium
Lac - Lacustrine
Sh - Shale
T - Till

Minimum infiltration rates are highly variable and are not readily related to any single site characteristic. The very low mean minimum infiltration rate of the Regosol soil can be ascribed to the poor structure of the surface mineral horizon and to the presence of the impervious horizon at the land surface (Appendix III-B). A high rate of infiltration is evident in the Dystric Brunisol which appears to be associated with the alluvial parent material. The minimum infiltration rates in the Gray Luvisol soils tend to be associated with slope characteristics, similar to that suggested by Linsley, Kohler and Paulhus (1949). Gray Luvisols occurring on slopes of less than 15 percent have a mean minimum infiltration rate of about 5 cm/hr. while those on slopes greater than 15 percent tend to be over 8 cm/hr. On the basis of these results the soils have been grouped into four infiltration rate classes. Soils in class A have a rate greater than 12 cm/hr., class B from 8-12 cm/hr., class C from 4-8 cm/hr., and soils in class D have a rate less than 4 cm/hr.

The mean minimum infiltration rates used are obtained from the mean infiltration curves presented in Figure 38. These curves are compiled from the four replicates obtained by a single infiltration experiment according to Kohnke's (1938) method. The results show that soil saturation is generally attained within 30 minutes of the start of the experiment.

Dispersion ratio values show that only two of the selected soils have a ratio less than 10 and, hence, are non-erodible (Anderson, 1951). The low ratio for the Regosol as well as for the Eutric Brunisol is likely the result of the relatively high amount of clay in the surface horizon (Appendix III-B). The very high erodibility of the

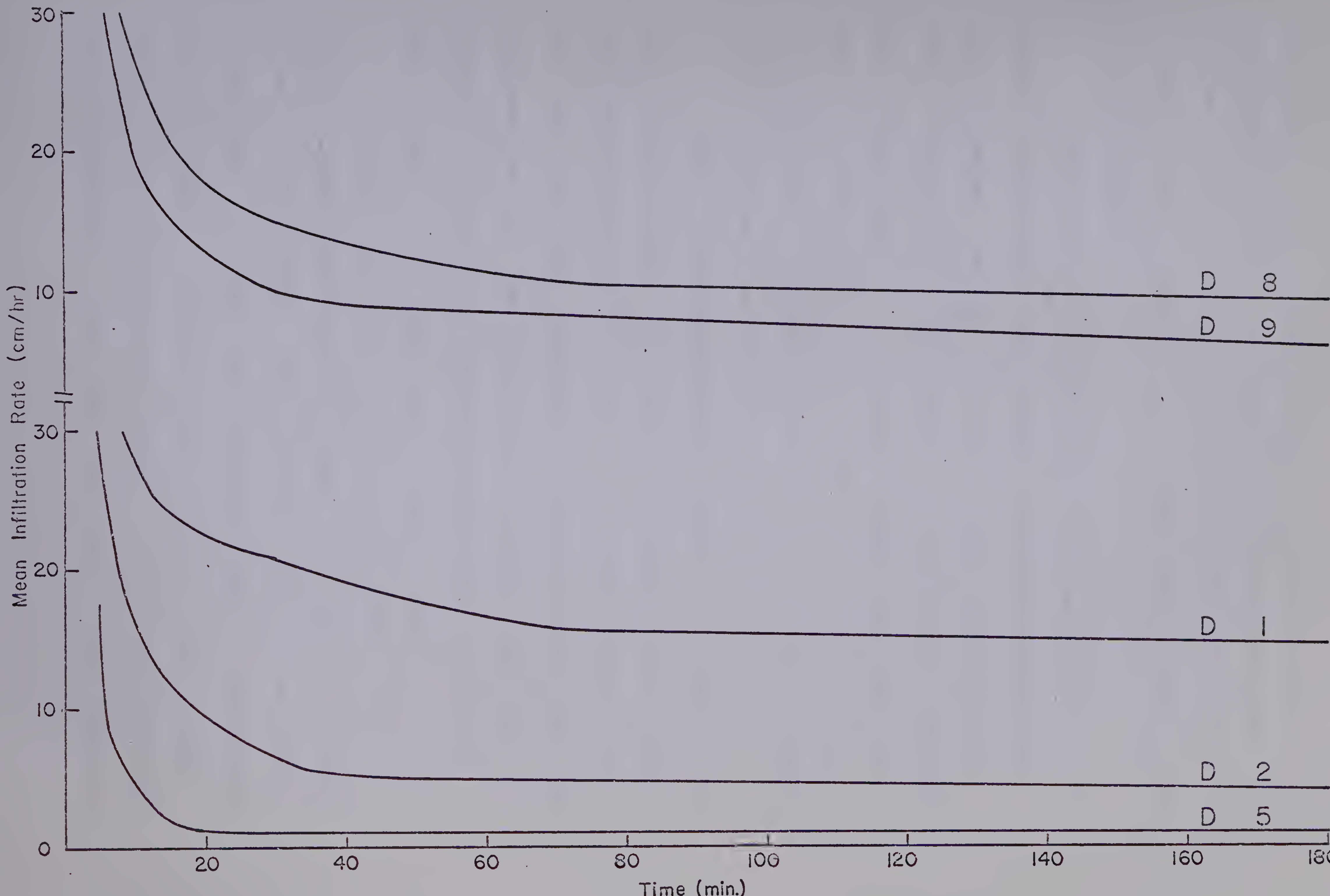


Figure 38. Mean infiltration rates of selected profiles from Deer Creek Basin.

Gray Luvisol at site 8 may be associated with the steep slope. Soil groupings for erodibility correspond to the following dispersion ratio classes: a ratio of less than 6% for soils in class A, 6-12% for those in class B, 12-18% for those in class C, and a ratio greater than 18% for soils in class D.

The results of the calculation of the compressibility ratio indicate that the Regosol and the Eutric and Dystric Brunisols are highly compacted. The Rego Black soil is highly compressible which may be ascribed to the "turfy" nature of the Ah1 horizon. Soil groupings delineated on the basis of compressibility ratio classes are: a ratio of 1-.85 for soils in class A, .85-.75 for soils in class B, .75-.65 for soils in class C, and less than .65 for soils in class D. All Gray Luvisol soils were assigned to ratio class C.

Total storage capacity results appear to be related to the nature of the A horizon. Soils having an A horizon in which organic matter has accumulated tend to have a total storage capacity greater than 12 in. Soils with a brunisolic Ae horizon generally have a capacity less than 4 in. The classes of total storage capacity into which the soils in the basin are grouped range then from over 12 in. for soils in class A to less than 4 in. for soils in class D.

Results for available moisture capacity show that the soils can be delineated into groups on the basis of the depth to the impeding horizon in the profile. The Gray Luvisol soils have an impeding horizon close to the surface and, consequently, have a very low available water capacity. The four classes delineated for depth to the impeding horizon and used for the grouping of soils in the basin have the following limits: class A greater than 18 in., class B from 12-18

in., class C from 6-12 in., and in class D, the impeding horizon is at less than 6 in. depth.

<u>Interpretive classifications</u>. The hydrologic parameters selected for interpretive use in the basin are minimum infiltration rate, total storage capacity, depth to impeding horizon, dispersion ratio and compressibility ratio. The mapping units of the survey area are grouped into the classes previously established for each of these parameters.

The suitability of the soils for water catchment is determined on the basis of the minimum infiltration rate class and the class for total storage. The suitability map presented in Figure 39 shows that a large proportion of the Gray Luvisol soils are poorly suited for water catchment. Brunisolic soils are generally fairly suitable while Chernozemic soils are highly suitable for water catchment. This implies that Chernozemic soils have a high final infiltration rate and a large total storage capacity.

Soil capability for water yield improvement is delineated on the basis of depth to the impeding horizon and the slope. The capability map (Fig. 40) shows that vegetation conversion would improve the water yield of most Gray Luvisol soils. However, it is questionable whether or not the improved water yield would be of economic significance. The basic hydrologic limitation of Gray Luvisol soils is the occurrence of an impervious horizon near the land surface. This impeding horizon will likely be altered only slightly by the conversion of the lodgepole pine forest to grass. As a consequence, to make such conversions economically justified, the impeding horizon would need to be broken up at the time of the conversion program.

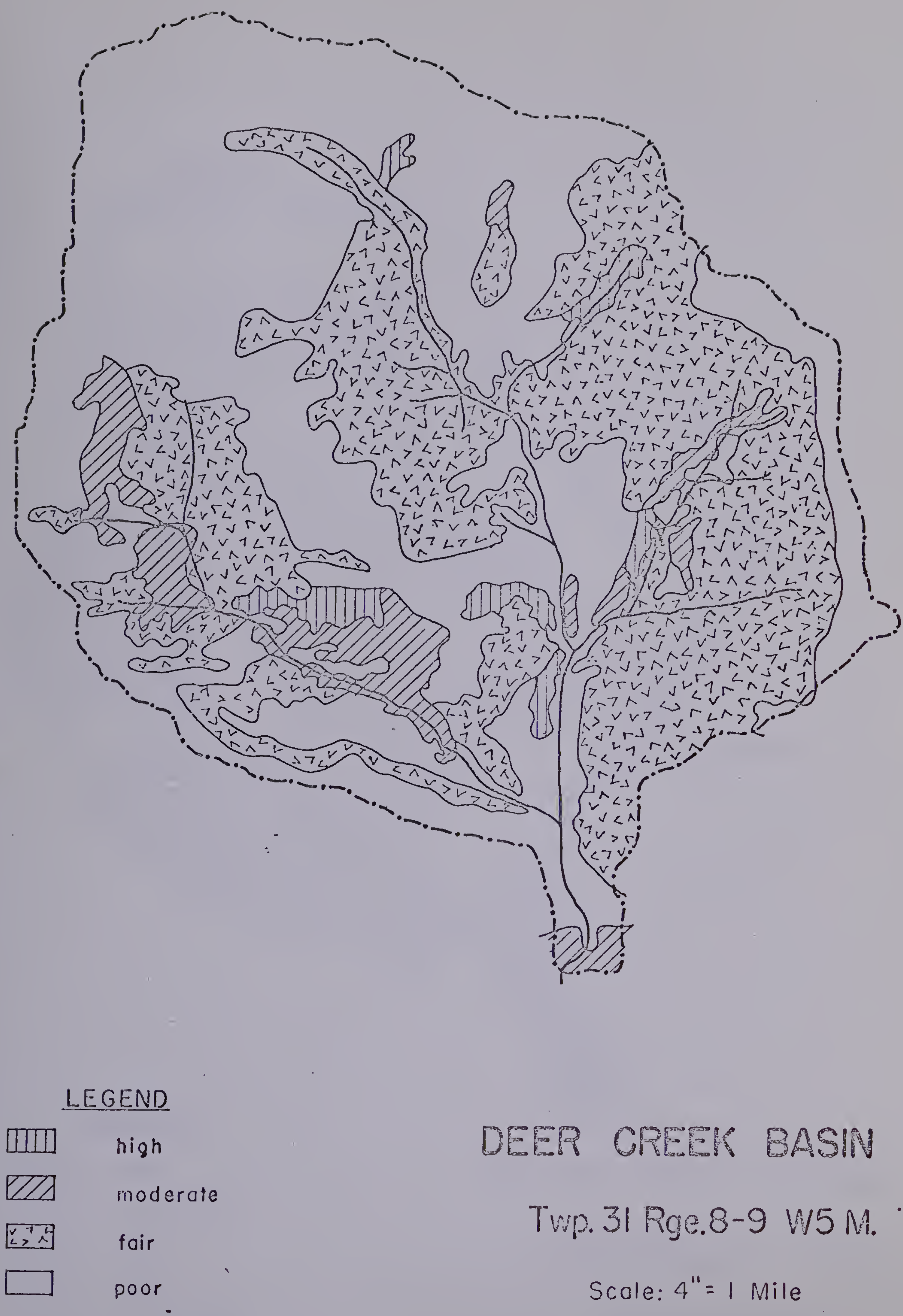


Figure 39. Suitability of the soils in Deer Creek Basin for water catchment.

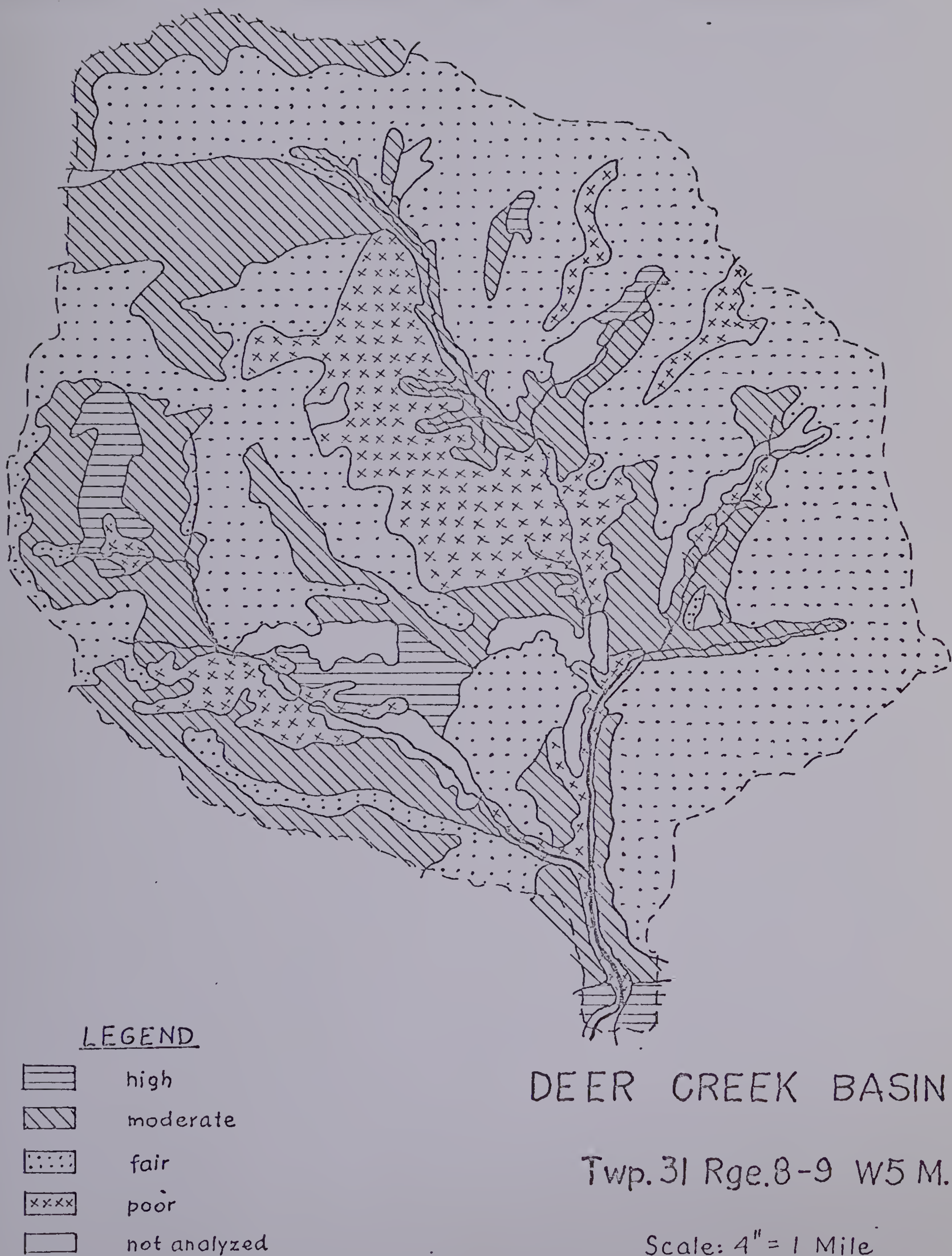


Figure 40. Capability of the soils in Deer Creek Basin for water yield improvement.

Soils that have a capability rating similar to their suitability rating are poorly suited for vegetation conversion. Grassland soils are not rated for water yield improvement because of insufficient information available on the suitability of grass species for such purposes.

VI. SUMMARY AND CONCLUSIONS

The three experimental watershed basins located in southwestern Alberta are highly variable with respect to the nature and kinds of soils present. This complexity is related to rapid changes in the effective combination of the soil forming factors within relatively short distances. Such conditions are found to be characteristic for mountainous areas (Duchaufour, 1965; Retzer, 1948).

Vertical zonation of soils is evident only in Marmot Creek Basin. The well-drained soils in this basin range from Gray Luvisols at the lower elevations and pass through Ferro-Humic Podzols and Dystric Brunisols to Regosols at the higher elevations. The characteristics of these soils become less pronounced with increase in elevation. Soils from the alpine tundra region of the basin support Griggs (1946) contention that the timberline in the Rocky Mountains reflects a climatic tension zone.

Streeter Creek Basin is characterized by the dominance of Black and Dark Gray Chernozemic soils, with Regosols, Eutric Brunisols and Gray Luvisols occupying lesser areas. These soils reflect a progressive increase in podzolization when arranged in a sequence of increasing soil degradation. The distribution pattern of the various Great Soil Groups or Subgroups are not readily delineated and reflect the tension-zone conditions of the climate in the region.

Deer Creek Basin has the most uniform soil distribution pattern of all the basins examined. Gray Luvisol soils are presnnt throughout this basin and occupy by far the largest area. Only minor areas of Regosols, Black and Dark Gray Chernozems, and Eutric and

Dystric Brunisols are encountered. The upland soils in the basin are generally moderately-well to imperfectly drained. Gleysolic and Organic soils are present to a limited extent in all three basins.

Examination of the data from this study indicates that the Canadian System of Soil Classification (N.S.S.C., 1968) cannot readily accommodate a large proportion of the mountain soils encountered in the three basins. The deficiencies of this classification system appear to be associated with the rigidity of the system at the higher levels of abstraction. This is clearly demonstrated by the criteria established for the Gleysolic Order, which is supposed to accommodate the poorly-drained soils. However, the apparent lack of gleying and/or mottling in poorly-drained soils from mountainous areas excludes them from being classified in the Gleysolic Order. Similar deficiencies are encountered for the classification of imperfectly-drained soils into the Gleyed Subgroup of any one Order established for well-drained soils.

The rigidity and lack of scope of the Canadian System of Soil Classification at the higher levels of abstraction is also evident from its inability to accommodate soils that have properties which, in part, meet the requirements of more than one Soil Order, Great Group, or Subgroup. Soils that have properties which are not defined at these levels of abstraction are also excluded from the classification. A large number of soils in the study areas fit into these categories. Such soils are presently classified into that Great Soil Group or Order which accommodates or reflects their dominant morphological and/or chemical characteristics. This mode of classification is contrary to the principle of an orderly arrangement which is prerequisite for

any classification system. It also limits the accuracy of soil survey interpretations, regardless of whether or not a phenotypic or genotypic system of classification is employed. These deficiencies of the Canadian System of Soil Classification could be alleviated either by decreasing the classification requirements with an increase in the level of abstraction or by delineating criteria for soils from mountainous areas at the higher levels of abstraction in the present classification system.

The use of a computer mapping technique for the compilation of soil survey information reduces the amount of time involved in the preparation of the final soil map and in the calculation of the area of mapping units. Computer mapping facilitates rapid modifications of existing maps as well as the delineation of any specific mapping unit from a map-sheet. Modification of the program would make it applicable for soil survey use on a national basis.

The hydrologic characteristics of the soils in the three experimental watershed basins are not readily associated with one particular environmental factor. The hydrologic parameters generally selected for interpretive use are minimum infiltration rate, total storage capacity, available water capacity and slope. Total storage and available water capacities are represented by the depth to the impervious horizon, when applicable. The selected parameters are each separated into classes and the mapping units are grouped accordingly. In general, the minimum infiltration rate of the soils in Marmot and Streeter Creek Basins are higher than the maximum storm-rainfall intensity.

The soils in Marmot and Streeter Creek Basins are generally better suited for water catchment than those of Deer Creek Basin. The anticipated effect of conversion of vegetation generally results in a minimal improvement of water yields. Soils on moderate slopes tend to be most responsive to such conversion programs. However, the soils in these positions normally belong to the Gray Luvisol Great Soil Group which have a relatively impermeable horizon close to the land surface. This implies that, in order to have economic justification for implementing conversion of vegetation, the impeding horizon needs to be broken up at the time of the conversion program.

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APPENDIX I-A

Key to Abbreviations

Slope:

d - moderately sloping (6-9%)
e - strongly (10-15%)
f - steeply (16-30%)
g - very steeply (30-60%)
h - excessively (> 60%)

Internal Drainage:

1 - rapid
2 - well
3 - moderately well
4 - imperfect
5 - poor
6 - very poor

Depth and Nature of Organic Horizons:

P - peat
T - turf
a - 5 cm < L-H
b - ≥ 5<121/2 cm L-H
c - ≥ 121/2 cm L-H

Nature of overlay:

TC - Till colluvium
RC - Residual colluvium
TCA - Till and aeolian colluvium mixxed
A - Aeolian
Al - Alluvium

Parent Material:

Tla - Till I non-compacted phase
Tlb - Till I compacted phase
T2 - Till II
RC - Residual colluvium
Res - Residuum
A - Aeolian
Al - Alluvium
TC - Till colluvium
TRC - Till + Residual colluvium

Depth to bedrock:

30 cm - less or equal to 30 cm
90 cm - greater than 30 and less or equal to 90 cm
blank - greater than 90 cm

Order	Great Group	Subgroup	Code	Slope	Inter. Drain.	Depth & Nature Org. Hor.	Nature Overlay	Depth Overlay (cm)	Parent Material	Depth Bedrock (cm)	Area (acres)
Luvisolic	Gray Luvisol	Orthic	A 1	f	3	a	TC	< 15	T1b		16
			2	e	3	a	TC	< 15	T1b		6
			3	f	2	a	TRC	> 15	T1a		11
			4	f	2	a	TRC	> 15	T1a		14
			5	e	3	a	TRC	> 15	T1b	90	17
			6	f	2	a	TRC	> 15	TRC		8
		Brunisolic	B 1	f	3	a	TC	< 15	T1b		32
			2	e	3	a	TC	< 15	T1b		41
			3	d	3	b	TC/A	< 15	T1b		8
			4	e	3	b	TC/A	< 15	T1b		5
			5	f	2	a	TC	> 15	T1b		39
			6	f	2	a	TC	> 15	T1b		20
			7	e	4	a	RC	< 15	Res		5
			8	f	2	c	TC/A	> 15	T1b		18
			9	f	3	b	TC/A	> 15	T1b		15
Podzolic	Ferro-Humic Podzol	Orthic	C 1	d	2	b	TC/A	> 15	T1b		10
			2	f	3	c	TC/A	> 15	T1a		8
			3	e	2	b	TC/A	> 15	T1a		40
			4	f	3	b	TC/A	> 15	T1a		11
			5	e	1	a	TC/A	> 15	A1		14
		Mini	D 2	g	2	b	TC/A	> 15	T1a		4
			L 1	e	2	b	TC/A	< 15	T1a		26
			0	f	4	c	TC/A	> 15	T1a		15
			L	d	2	b	TC/A	> 15	T1a		8
Regosolic	Regosol	Orthic	E 1	e	3	a	RC	> 15	Dol. Res.	< 30	1
			2	e	2	a	RC	> 15	Sandst. Res.	< 30	.2
			3	h	1	T	RC	> 15	RC	< 90	199

Order	Great Group	Subgroup	Code	Slope	Inter. Drain.	Depth & Nature Org. Hor.	Nature Overlay	Depth Overlay (cm)	Parent Material	Depth Bedrock (cm)	Area (acres)
Regosolic	Regosol	Orthic	E 4	g	2	T	RC	> 15	RC	< 90	125
			5	h	3	T	RC	> 15	RC	< 30	74
			6	h	2	T	RC	> 15	RC	< 30	3
			7	f	2	T	RC	> 15	RC	< 30	31
			8	e	4	a	Al	> 15	Al		14
			9	f	4	a	TC	> 15	TC		2
			0	g	4	T	RC	> 15	RC	< 90	21
			G 1	h	3	T	TC	> 15	RC	< 90	11
			2	h	4	T	RC	> 15	RC	< 30	3
		Orthic (formerly Deorcic)	F 1	g	2	T	RC	> 15	RC	< 90	22
			2	h	2	T	RC	> 15	RC	< 90	86
			3	h	3	T	RC	> 15	RC	< 90	15
			4	g	3	T	RC	> 15	RC		22
			5	h	2	T	RC	> 15	RC		14
			6	f	2	T	TC	< 15	T2		13
			7	g	3	a	RC	> 15	T2		15
			8	g	2	a	TRC	> 15	T2	< 90	2
			9	h	3	a	RC	> 15	RC	< 90	2
			H 1	f	2	T	TC	> 15	TC		2
			2	h	1	T	TC	> 15	TC		11
			3	f	2	b	Al	> 15	T1a		3
			4	f	4	b	Al	> 15	TC		2
			5	e	4	a	Al	> 15	Al		23
			6	h	5	T	RC	> 15	RC		0
			7	g	3	T	Al	> 15	RC	< 90	2
		Cumulic	O 1	h	2	T	RC	> 15	RC		53
			2	h	4	T	TC	> 15	TC		5

Order	Great Group	Subgroup	Code	Slope	Inter. Drain.	Depth & Nature Org. Hor.	Nature Overlay	Depth Overlay (cm)	Parent Material	Depth Bedrock (cm)	Area (acres)
Brunisolic	Eutric Brunisol	Orthic	I 1	e	4	b	TCA	> 15	Tla		32
			2	e	4-5	c	TCA/Al	< 15	Tla		20
			3	d	4	b	TCA	> 15	TC		17
		Degraded	J 1	h	4	b	TC	< 15	Tla		101
	Dystric Brunisol	Orthic	K 1	e	3	b	TC/A	> 15	Tla		2
		Degraded (class A)	L 2	f	2	b	TC/A	> 15	Tla		45
			3	g	2	b	TC/A	> 15	Tla		116
			4	g	1	b	TC/A	> 15	Tla		27
			5	d	3	a	TC/A	< 15	Tlb		9
			6	f	3	b	TC/A	< 15	Tlb		10
			7	f	3	b	TC/A	< 15	Tla		36
			9	f	3	a	TC/A	< 15	Tla		22
		Degraded (class B)	D 1	d	3	b	TC	< 15	Tla		8
			L 8	g	1	a	TC	> 15	Tla	some < 90	19
			M 1	g	2	b	TC	> 15	Tla		68
			2	g	2	b	TC	> 15	T2		28
			3	g	1	a	TC	> 15	T2		59
			4	f	3	a	TC	< 15	T2		33
			5	h	2	b	RC	> 15	Tla		6
			6	h	1	c	RC	> 15	RC		16
			7	h	2	b	RC	> 15	RC	< 90	5
			8	h	4	b	RC	> 15	RC	< 30	4

Order	Great Group	Subgroup	Code	Slope	Inter. Drain.	Depth & Nature Org. Hor.	Nature Overlay	Depth Overlay (cm)	Parent Material	Depth Bedrock (cm)	Area (acres)
		Alpine	N 1	g	2	a	RC	> 15	T2		22
		(class A)	2	h	2	a	RC	> 15	RC	< 90	53
			3	h	2	a	RC	> 15	T2		11
			4	f	3	a	RC	> 15	T2		14
			5	g	2	a	RC	> 15	RC	< 90	47
		Alpine	P 1	h	2	T	RC	> 15	RC	< 90	25
		(class B)	2	g	2	T	TC	> 15	T2		2
			3	h	2	T	RC	> 15	RC		8
Glysolic	Gleysol	Rego,	Q 1	c	6	P	TRC	> 15	RC		14
		Carb.	2	f	5	P	TCA	> 15	Tlb		9
			3	e	6	P	TC/A	> 15	TC		7
		Rego,	R 1	e	5	P	TCA	> 15	TCA		6
		Peaty Carb.	2	e	5	P	TC	> 15	Res		1
		Rego,	S 1	f	5	P	TCA	> 15	Tla		9
		Peaty	2	f	5	P	TC/A	> 15	Tla		17
	Humic	Orthic	T 1	e	5	P	RCA/A1	> 15	T2		18
	Gleysol	Subalp.	2	f	5	P	RC	> 15	T2		1
		Rego,	U 1	g	6	T	RC	> 15	RC	< 30	60
		Subalp.	2	f	6	P	TC	> 15	TC		5
			3	g	6	P	TC	> 15	T2		3
			4	f	5	P	RC	> 15	Tla		5

Order	Great Group	Subgroup	Code	Slope	Inter. Drain.	Depth & Nature Org. Hor.	Nature Overlay	Depth Overlay (cm)	Parent Material	Depth Bedrock (cm)	Area (acres)
		Rego, Peaty	V 1	e	6	P	A	> 15	Tla		4
Organic	Fibrisol	Terric	W 1	f	6	P	A	> 15	Tla		1
			2	e	6	P	A	> 15	Tla		8
Rock			X 1								94

APPENDIX I-B

Key to Appendix I-B

The morphological descriptions and analytical results of the soil profiles sampled in Marmot Creek Basin are presented in order of sampling site sequence. Explanation of abbreviations used are as follows:

Ino. C - Inorganic Carbon

Org. C - Organic Carbon

Exch. Acid. - Exchange Acidity

pH Depend. C.E.C. - pH Depended Cation Exchange Capacity

G - Coarse skeleton (> 2 mm)

S - Sand (2 mm - 50 μ)

Si - Silt (50 μ - 2 μ)

C - Clay (2 μ - .2 μ)

FC - Fine clay (< .2 μ)

Bulk Dens. - Bulk Density

Por. - Porosity (calculated from bulk density and specific gravity data)

Sat. Cap. - Saturation Capacity

(Theor.) - Theoretical Saturation Capacity (Richards and Wadleigh, 1952)

Avail. Moist. - Available Moisture

Hygr. Moist. - Hygroscopic Moisture

Sub-group: .... Peaty Carbonated Rego Gleysol.

Profile number: .... M1.

Location: .... Near Forestry Plot #190.

Vegetation: Tree canopy: .... *Picea* sp..

Understory: .... *Salix* sp., *Lonicera* sp., *Potentilla fruticosa*.

Ground: .... *Aster* sp., *Gramineae* spp., *Parnassia* sp., *Equisetum* sp., *Thalictrum* sp..

Parent material: .... Colluvium/Colluvium/Aeolian/Till I.

Topography: .... Moderately sloping; aspect S.E.,

Elevation: .... 5840 ft. M.S.L..

Drainage: .... Poorly drained.

Horizon	Depth (cm)	Description
L	25 - 22	Matted, undecayed organic material.
F - H	22 - 8	Spongy, partially and fully decayed organic material.
H	8 - 0	Dense, fully decayed organic material.
C	0 - 18	Very dark brown (10 YR 2/2) silt loam, dark gray (10 YR 4/1) when dry; weak, medium granular to amorphous; friable; pH 7.4; slight effervescence; clear, smooth boundary.
II C	18 - 29	Very dark grayish brown (10 YR 3/2) silt loam, dark grayish brown to grayish brown (10 YR 4/2-5/2) when dry; single grained to amorphous; very friable; pH 7.5; slight effer-

Horizon	Depth (cm)	Description
IIC	18 - 29	vescence; moderately gravelly; abrupt, smooth boundary.
IIIH	29 - 31	Dense, altered organic material.
IIIAh	31 - 35	Dark reddish brown (5 YR 3/3) silt loam, light gray (10 YR 7/2) when dry; weak platy; very friable; pH 7. 6; slight effervescence; clear, wavy boundary.
IIIC	35 - 48	Yellowish brown (10 YR 5/6-5/8) silt loam, very pale brown (10 YR 7/3-8/4) when dry; strong platy; very friable; pH 7. 7; slight effervescence; abrupt smooth boundary.
IVAh	48 - 51	Black (10 YR 2/1) silty clay loam, dark brown (10 YR 3/3) when dry; weak, medium granular to amorphous; friable; pH 7. 3; slight effervescence; gradual, smooth boundary.
IVC	51 - 66 +	Very dark grayish brown to dark brown (10 YR 3/2-3/3) silt loam to loam, dark gray to dark grayish brown (10 YR 4/1-4/2) when dry; single grained to amorphous; friable; pH 7. 5; slight effervescence.

Sub-group: Peaty Carbonated Rego Gleysol   Profile No. M1.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L	25-22	7.2	nd	nd	34.6	1.30	26	nd	.3	4.8	80.7	14.2	92.3	nd
F-H	22-8	7.2	nd	nd	36.6	1.58	23	nd	.2	1.2	91.3	7.3	139.7	nd
H	8-0	7.1	nd	nd	25.8	1.34	19	nd	.3	.5	90.6	8.6	141.1	nd
C	0-18	7.4	.38	nd	nd	nd	nd	nd	.7	1.4	91.5	6.4	23.6	nd
IIC	18-29	7.5	.82	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
IIIAh	29-35	7.6	.40	3.0	nd	.20	nd	nd	.7	2.6	87.0	9.6	20.9	nd
IIIC	35-48	7.7	.40	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
IVAh	48-51	7.3	.24	nd	9.0	.45	20	nd	.7	1.2	95.3	2.8	47.7	nd
IVC	51-66+	7.5	.75	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L	25-22	nd	nd	nd	nd	nd	nd	nd	nd	384.4	135.4	100.9	34.5	8.6	nd	nd	nd
F-H	22-8	nd	nd	nd	nd	nd	nd	nd	nd	343.3	169.9	114.1	55.8	12.3	nd	nd	nd
H	8-0	nd	nd	nd	nd	nd	nd	nd	nd	226.3	133.2	80.2	47.0	11.4	nd	nd	nd
C	0-18	3	24	55	21	8	1.11	55.8	50	42.8	24.1	10.6	13.5	2.1	nd	nd	nd
IIC	18-29	13	26	54	20	8	1.26	51.4	41	26.7	14.7	7.6	7.1	1.6	nd	nd	nd
IIIAh	29-35	0	28	63	9	4	.79	66.3	84	62.6	32.0	9.9	22.1	2.4	nd	nd	nd
IIIC	35-48	0	17	76	7	2	.70	69.7	80	nd	43.6	9.0	34.6	2.7	.36	.04	.40
IVAh	48-51	0	15	53	32	17	1.01	nd	nd	42.5	36.0	19.0	17.0	nd	nd	nd	nd
IVC	51-66+	12	28	50	22	7	1.23	nd	nd	30.7	21.7	8.9	13.8	nd	nd	nd	nd

Sub-group: .... Brunisolic Gray Luvisol.

Profile number: .... M2.

Location: .... Between Forestry Plot #32-33.

Vegetation: Tree canopy: ...... _Pinus contorta_, _Picea_ sp..

Understory: .... _Salix_ sp., _Ribes_ sp..

Ground: .... _Epilobium_ sp., _Aster_ sp., _Vaccinium_ sp..

Parent material: .... Mixed Aeolian and Till Colluvium/ Till I, compacted phase.

Topography: .... Very steeply sloping; aspect N. E..

Elevation: .... 5680 ft. M. S. L..

Drainage: .... Moderately well.

Horizon	Depth (cm)	Description
L - H	1 - 0	Organic material in various stages of decomposition.
(Ae)	0 - 2	Brown (10 YR 5/3) silt loam, very pale brown (10 YR 7/3) when dry; weak, medium platy; very friable; pH 6.5; gradual, smooth boundary.
(Bf)	2 - 15	Dark brown (7.5 YR 4/4) silt loam, light yellowish brown (10 YR 6/4) when dry; weak, medium platy breaking to weak, fine granular; friable; pH 6.8; clear wavy boundary.
IIAe	15 - 21	Yellowish brown (10 YR 5/4) silt loam, very pale brown when dry; weak, coarse platy; very friable; pH 6.7; slightly

Horizon	Depth (cm)	Description
IIAe	15 - 21	gravelly; clear, wavy boundary.
IIBt	21 - 37	Dark Brown (10 YR 4/3) clay loam, brown (10 YR 5/3) when dry; strong, medium subangular blocky; firm; pH 6.8; very cobbly; clear, wavy boundary.
IIBC	37 - 47	Very dark grayish brown (10 YR 3/2) clay loam, dark grayish brown (10 YR 4/2) when dry; weak, medium sub-angular blocky; firm; pH 7.1; slight effervescence; moderately gravelly to cobbly; clear, wavy boundary.
IIC	47 - 150	Black (10 YR 2/1) loam, dark gray (10 YR 4/1) when dry; amorphous; friable; pH 7.5; strong effervescence; moderately cobbly;

Sub-group: Brunisolic Gray Luvisol — Profile No. M2.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	1-0	6.5	nd	nd	34.5	.92	38	8.7	.3	2.0	68.2	20.8	103.2	nd
(Ae)	0-2	6.5	nd	nd	1.97	.09	23	5.5	.5	4.0	74.1	15.9	20.1	nd
(Bf)	2-15	6.8	nd	nd	2.08	.10	20	11.2	1.2	2.8	84.8	nd	17.8	nd
IIAe	15-21	6.7	nd	nd	1.08	.05	22	4.8	7.1	3.2	84.9	nd	12.6	nd
IIBt	21-37	6.8	nd	nd	1.43	.07	19	1.9	1.9	2.3	78.8	15.0	26.0	nd
IIBC	37-47	7.1	.97	nd	nd	nd	nd	nd	.4	2.1	86.7	10.8	24.1	nd
IIC	47-150	7.5	17.14	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	1-0	nd	nd	nd	nd	nd	nd	nd	nd	282.0	121.2	66.9	56.3	7.7	.05	.01	.06
(Ae)	0-2	0	17	62	21	8	nd	nd	nd	34.0	22.3	7.5	14.8	1.5	.05	.01	.06
(Bf)	2-15	0	24	57	19	5	nd	nd	nd	52.0	43.1	11.8	31.3	3.6	.21	1.00	1.21
IIAe	15-21	0	17	67	16	5	nd	nd	nd	33.5	22.6	5.4	17.2	1.2	.05	.02	.07
IIBt	21-37	0	21	40	39	23	nd	nd	nd	35.2	22.1	13.1	9.0	2.4	.10	.06	.16
IIBC	37-47	0	24	43	33	20	nd	nd	nd	30.3	22.1	11.0	10.1	2.0	.10	.00	.10
IIC	47-150	0	39	41	20	14	nd	nd	nd	20.8	13.4	5.0	8.4	.8	.07	.00	.07

Sub-group: .... Brunisolic Gray Luvisol (imperfectly drained).

Profile number: .... M3.

Location:........................ Near Forestry Plot # 31.

Vegetation: Tree canopy:........ *Pinus contorta*, *Picea* sp., *Populus* sp..

Understory: .... *Salix* sp..

Ground: .... Moss.

Parent material:................ Residual Colluvium/Residual Shale.

Topography: .... Moderately sloping; aspect E..

Elevation: .... 5470 ft. M.S.L.

Drainage: .... Imperfect.

Horizon	Depth (cm)	Description
L - H	2 - 3	Organic material in various stages of decomposition.
(Ae)	0 - 3	Grayish brown (10 YR 5/2) silt loam, light gray to very pale brown (10 YR 7/2-7/3) when dry; strong, medium platy; very friable; pH 5.6; clear, wavy boundary.
(Bfj)	3 - 8	Reddish brown (5 YR 4/4) silt loam to silty clay loam, pale brown (10 YR 6/3) when dry; weak, medium platy breaking to strong, medium granular; friable; pH 6.3; clear wavy boundary.
IIAe	8 - 11	Yellowish brown (10 YR 5/4) silt loam, very pale brown (10 YR 8/4) when dry; strong, coarse platy; very friable;

Horizon	Depth (cm)	Description
IIAe	8 - 11	pH 6.1; slightly angular gravelly; gradual, smooth boundary.
IIAB	11 - 14	Grayish-brown to brown (10 YR 5/2-5/3) silty clay, pale to very pale brown (10 YR 6/3-7/3) when dry; strong, coarse subangular blocky breaking to strong, coarse platy; friable; pH 5.8; slightly angular gravelly; clear, smooth boundary.
IIBt	14 - 26	Olive gray (5 Y 4/2) silty clay, brown (10 YR 5/3) when dry; strong, coarse subangular blocky; firm; pH 5.9; slightly angular gravelly; gradual, smooth boundary.
IIBC	26 - 31	Olive gray (5 Y 4/2) silty clay, dark grayish brown to dark brown (10 YR 4/2-4/3) when dry; strong, medium granular to moderate, coarse subangular blocky; firm; pH 6.5; gradual, smooth boundary.
IIC1	31 - 62	Black to very dark brown (10 YR 2/1-2/2) silty clay, dark brown (10 YR 4/3) when dry; pseudo platy; firm; pH 7.5; strong effervescence; clear, smooth boundary.

Horizon	Depth (cm)	Description
IIC2	62 - 68+	Very dark brown to very dark grayish brown (10 YR 2/2-3/2) silty clay loam, light brownish gray (10 YR 6/2) when dry; pseudo platy; firm; pH 7.5; violent effervescence.

Sub-group: Brunisolic Gray Luvisol

Profile No. M3.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	2-0	5.8	nd	nd	26.4	.9	30	13.7	.7	3.3	67.7	14.6	75.8	nd
(Ae)	0-3	5.6	nd	nd	2.8	.1	27	20.5	.5	3.2	58.4	17.3	54.5	nd
(Bfj)	3-8	6.3	nd	nd	1.9	.1	22	17.9	1.2	4.0	60.1	16.8	19.5	nd
IIAe	8-11	6.1	nd	nd	.9	.0	20	12.9	3.0	2.0	68.3	13.8	7.7	nd
IIAB	11-14	5.8	nd	nd	1.6	.1	18	8.8	.5	1.8	70.5	18.4	18.9	nd
IIBt	14-26	5.9	nd	nd	1.9	.1	18	7.3	.8	2.0	78.0	11.8	16.3	nd
IIBC	26-31	6.5	nd	nd	3.1	nd	nd	nd	.6	.9	91.5	7.0	19.6	nd
IIC-1	31-62	7.5	23.6	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
IIC-2	62-68+	7.5	38.6	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	2-0	nd	nd	nd	nd	nd	nd	nd	nd	25.7	93.3	65.3	28.0	6.19	.05	.02	.07
(Ae)	0-3	0	21	60	19	8	.94	61.9	66	45.1	35.5	9.1	26.4	1.43	.08	.00	.08
(Bfj)	3-8	0	17	56	27	13	.94	62.2	66	47.2	43.0	14.0	29.0	2.80	.24	.04	.28
IIAe	8-11	2	19	65	16	6	nd	nd	nd	21.4	22.6	4.3	18.3	0.92	.10	.02	.12
IIAB	11-14	1	9	45	46	19	1.14	57.1	50	62.5	25.5	13.4	12.1	1.87	.09	.01	.10
IIBt	14-26	0	2	41	57	30	1.14	56.8	80	34.6	28.0	17.1	10.9	2.3	.10	.03	.13
IIBC	26-31	0	2	44	54	19	.91	65.7	72	39.2	33.6	19.6	14.0	2.4	.08	.06	.14
IIC-1	31-62	0	3	47	50	17	1.38	48.5	36	33.4	26.3	14.1	12.2	1.6	.06	.00	.06
IIC-2	62-68+	0	2	59	39	21	1.26	52.8	42	32.9	29.5	11.4	18.1	1.2	.06	.01	.07

Sub-group: .... Alpine Dystric Brunisol, (Class A)

Profile number:.................... M4.

Location:.......................... 5 chains West of Forestry Plot #508

Vegetation: Tree canopy:.......... _Picea_ sp., _Larix_ sp..

Understory.......... ---

Ground:.............. _Arnica_ sp., _Vaccinium_ sp., _Pedicularis_ sp..

Parent material:.................. Residual colluvium/Rock.

Topography:........................ Extremely sloping; aspect E..

Elevation:......................... 7110 ft. M.S.L.

Drainage:.......................... Well.

Horizon	Depth (cm)	Description
L - H	4 - 0	Organic material in various stages of decomposition.
Ahe	0 - 8	Very dark grayish brown (10 YR 3/2) silty clay loam, gray (10 YR 5/1) when dry; weak, medium platy; very friable; pH 5.1; gradual, wavy boundary.
Aeh	8 - 14	Dark grayish brown (10 YR 4/2) silty clay loam, light brownish gray (10 YR 6/2) when dry; weak, medium platy; very friable; pH 5.0; gradual, wavy boundary.
Bfhj	14 - 28	Very dark grayish brown (10 YR 3/2) silty clay loam, grayish brown (10 YR 5/2) when dry; weak medium granular; very friable; pH 5.1; gradual smooth boundary.

Horizon	Depth (cm)	Description
Bfj	28 - 56	Dark brown (10 YR 3/3) silty clay loam, grayish brown (10 YR 5/2) when dry; weak medium granular; friable; pH 5.1; gradual, smooth boundary.
C	56 - 85	Dark gray to very dark gray (10 YR 4/1-3/1) silt loam, grayish brown (10 YR 5/2) when dry; amorphous; very friable; pH 5.1;
Rock	85 +	

Sub-group: Alpine Dystric Brunisol (Class A) Profile No. M4.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	4-0	5.4	nd	nd	23.3	1.0	24	27.1	.2	5.8	54.1	12.8	51.0	nd
Ahe	0-8	5.1	nd	nd	8.5	.4	27	39.9	3.6	2.9	48.2	5.4	14.6	99.5
Aeh	8-14	5.0	nd	nd	5.2	.2	28	35.6	1.4	1.4	49.6	12.0	24.1	94.4
Bfhj	14-28	5.1	nd	nd	6.0	.2	31	59.8	.8	2.3	27.3	9.8	18.3	96.8
Bfj	28-56	5.1	nd	nd	5.2	.2	31	63.6	.7	2.1	33.6	0	18.8	95.8
C	56-85	5.1	nd	nd	2.0	nd	nd	37.7	.6	.6	47.4	13.7	15.8	94.4
Rock	85+	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	4-0	nd	nd	nd	nd	nd	nd	nd	nd	190.0	63.6	49.5	14.1	4.37	.05	.00	.05
Ahe	0-8	1	17	54	29	8	nd	nd	nd	57.1	21.3	11.8	9.5	1.98	.09	.05	.14
Aeh	8-14	5	19	52	29	10	1.17	51.5	44	36.0	18.6	8.5	10.1	1.65	.06	.00	.06
Bfhj	14-28	9	16	56	28	9	.91	62.9	69	30.2	15.1	7.7	7.4	1.47	.08	.00	.08
Bfj	28-56	4	16	54	30	9	1.09	55.7	51	26.9	18.8	8.4	10.4	1.77	.14	.00	.14
C	56-85	8	20	54	26	8	nd	nd	nd	20.5	14.3	6.4	7.9	1.34	.08	.00	.08
Rock	85+	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Sub-group: .... Degraded Dystric Brunisol, (Class B)

Profile number: .... M5.

Location:........................ Near Forestry Plot # 527.

Vegetation: Tree canopy......... *Picea* sp., *Abies* sp..

Understory:......... *Abies* sp..

Ground:............. *Vaccinium scoparium*, Moss.

Parent material:................ Till I.

Topography:...................... Moderately sloping; aspect S.S.W..

Elevation:....................... 6770 ft. M.S.L..

Drainage:........................ Moderately well.

Horizon	Depth (cm)	Description
L	4 - 3	Matted, undecayed organic material
F - H	3 - 0	Spongy, partially and fully decayed organic material.
Ae	0 - 10	Gray (10 YR 5/1-6/1) silt loam, light gray (10 YR 7/1) when dry; strong coarse platy; friable; pH 4.5; moderately angular cobbly; clear, wavy boundary.
Bfhj	10 - 17	Reddish brown (5 YR 4/3-4/4) clay loam, pink (10 YR 7/3) when dry; strong, medium granular; friable; pH 4.9; moderately angular cobbly; gradual, wavy boundary.
Bfj	17 - 28	Brown (7.5 YR 5/2-4/2) silt loam, very pale brown to light yellowish brown (10 YR 7/3-6/4) when dry:

Horizon	Depth (cm)	Description
Bfj	17 - 28	weak, coarse subangular blocky breaking to strong, medium granular; friable; pH 5.0; moderately to very angular cobbly; gradual smooth boundary.
BC	28 - 42	Very dark grayish brown (10 YR 3/2) silt loam, grayish brown to brown (10 YR 5/2-5/3) when dry; weak, coarse granular; friable; pH 5.0; moderately to very angular cobbly; gradual, smooth boundary.
C	42 - 60 +	Very dark brown (10 YR 2/2) silty clay loam, dark gray to dark grayish brown (10 YR 4/1-4/2) when dry; amorphous; firm; pH 5.7; very angular gravelly.

Sub-group: Degraded Dystric Brunisol (Class B) Profile No. M5.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L	4-3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
F-H	3-0	4.3	nd	nd	28.7	.81	35	68.2	.2	1.3	24.8	5.5	64.9	nd
Ae	0-10	4.5	nd	nd	3.9	.12	32	66.6	.7	1.3	30.1	1.3	15.1	92.8
Bfhj	10-17	4.9	nd	nd	2.9	.10	29	31.1	1.0	1.0	29.7	37.2	20.4	92.4
Bfj	17-28	5.0	nd	nd	2.9	.09	33	56.1	.9	1.9	31.8	9.3	12.7	94.0
BC	28-42	5.0	nd	nd	2.7	nd	nd	53.1	1.0	3.1	37.7	5.1	12.1	84.9
C	42-60+	5.7	nd	nd	4.3	nd	nd	15.3	.5	1.1	74.4	8.7	16.9	99.7

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L	4-3	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
F-H	3-0	nd	nd	nd	nd	nd	nd	nd	nd	196.1	194.6	54.4	140.2	4.8	.05	.00	.05
Ae	0-10	16	23	55	22	9	1.01	57.9	57	33.5	25.0	7.2	17.8	1.4	.04	.00	.04
Bfhj	10-17	22	21	49	30	11	1.07	57.7	53	33.7	25.2	11.4	13.8	1.9	.27	.11	.38
Bfj	17-28	26	25	52	23	8	.94	62.4	66	22.9	18.3	7.3	11.0	1.4	.20	.00	.20
BC	28-42	28	27	52	21	7	1.06	58.3	55	22.1	17.4	6.5	10.9	1.2	.16	.01	.17
C	42-60+	36	20	53	27	11	1.39	45.1	32	24.6	20.8	9.2	11.6	1.5	.06	.00	.06

Sub-group:........................Cumulic Regosol.

Profile number:.................. M6.

Location:........................ 10 chains west of F.I. Plot # 492

Vegetation: Tree canopy:......... Picea sp..

Understory:.......... Salix sp., Potentilla fruticosa.

Ground:.............. Grasses, Forbs.

Parent material:................. Residual colluvium.

Topography:...................... Extremely sloping; aspect S.E..

Elevation:....................... 7260 ft. M.S.L..

Drainage:........................ Well.

Horizon	Depth (cm)	Description
Ah1	0 - 26	Black (10 YR 2/1) silt loam, black (10 YR 2/1) when dry; weak, fine granular; very friable; pH 6.3; slightly slaty; gradual, wavy boundary.
Ah2	26 - 63	Black (10 YR 2/1) silt loam, black (10 YR 2/1) when dry; weak, fine granular; very friable; pH 6.5; slightly slaty; clear, smooth boundary.
Ah3	63 - 100	Black (10 YR 2/1) silt loam, black (10 YR 2/1) when dry; weak, fine granular; very friable; pH 6.7; moderately slaty; gradual, smooth boundary.
C	100 - 110 +	Very dark brown (10 YR 2/2) silt

Horizon	Depth (cm)	Description
C	100 - 110 +	loam, very dark gray to dark gray (10 YR 3/1-4/1) when dry; single grained; very friable; pH 6.9; very to exceedingly slaty.

Sub-group: Cumulic Regosol

Profile No. M6.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
Ah-1	0-26	6.3	nd	nd	11.3	.47	24	6.8	1.3	1.3	85.0	5.6	24.1	nd
Ah-2	26-63	6.5	nd	nd	7.8	.31	25	3.3	.3	.6	83.7	12.1	26.2	nd
Ah-3	63-100	6.7	nd	nd	10.3	.31	34	1.2	3.0	.3	83.6	11.9	26.9	nd
C	100-110	6.9	nd	nd	5.9	.19	nd	5.2	.5	.5	89.6	4.2	19.2	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
Ah-1	0-26	1	13	64	23	6	.74	67.7	91	64.8	25.9	21.0	4.5	nd	nd	nd	nd
Ah-2	26-63	8	11	66	23	6	1.05	54.1	51	49.7	22.7	16.5	6.2	nd	nd	nd	nd
Ah-3	63-100	6	15	62	23	7	.76	67.9	90	34.4	20.0	10.7	9.3	nd	nd	nd	nd
C	100-110	61	20	59	21	7	nd	nd	nd	26.7	19.1	9.9	9.2	1.37	nd	nd	nd

Sub-group:........................ Degraded Dystric Brunisol, (Class B)

Profile number: .... M7.

Location:........................ Near Forestry Plot # 236.

Vegetation: Tree canopy.......... *Picea* sp..

Understory........... ---

Ground:.............. Moss; *Vaccinium scoparium*.

Parent material:................. Colluvium/Colluvium/Till I.

Topography:...................... Extremely sloping; aspect E..

Elevation:....................... 6500 ft. M.S.L..

Drainage:........................ Well.

Horizon	Depth (cm)	Description
L - H	11 - 0	Organic material in various stages of decomposition.
Bm	0 - 4	Dark reddish brown (5 YR 3/2) silty clay loam, light reddish brown (5 YR 6/3) when dry; weak, medium subangular blocky; friable; pH 4.3; abrupt, smooth to wavy boundar.
IIAhej	4 - 14	Very dark grayish brown (10 YR 3/2) silty clay loam, dark gray to dark grayish brown (10 YR 4/1-4/2) when dry; weak, coarse subangular blocky; friable; pH 4.7; clear, wavy boundary.
IIAej	14 - 19	Reddish gray (5 YR 5/2) silt loam, light brownish gray (10 YR 6/2) when dry; weak, coarse subangular blocky breaking to weak, coarse platy; friable; pH 4.6; clear, wavy boundary.

Horizon	Depth (cm)	Description
IIIBfj	19 - 34	Brown (10 YR 5/3-4/3) silty clay loam, pale brown to light yellowish brown (10 YR 6/3-6/4) when dry; strong, coarse subangular blocky; friable; pH 5.1; gradual, smooth boundary.
IIIBC	34 - 54	Very dark grayish brown (10 YR 3/2) silty clay loam, grayish brown (10 YR 5/2) when dry; weak, medium sub-angular blocky; friable; pH 5.8; gradual, smooth boundary.
IIIC	54 - 80 +	Very dark gray (10 YR 3/1) silty clay loam, gray to grayish brown (10 YR 5/1-5/2) when dry; amorphous; pH 6.2; friable.

Sub-group: Degraded Dystric Brunisol (Class B) Profile No. M7.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	11-0	4.2	nd	nd	26.9	.8	35	63.5	.2	1.8	28.4	6.0	67.0	nd
Bm	0-4	4.3	nd	nd	4.1	.2	24	63.5	1.2	1.2	29.9	4.2	17.3	93.9
IIAhej	4-14	4.7	nd	nd	7.0	.3	28	61.3	.5	1.4	31.1	5.7	24.8	95.7
IIAej	14-19	4.6	nd	nd	3.0	.1	24	47.4	.7	2.2	40.9	8.8	14.7	95.5
IIIBfj	19-34	5.1	nd	nd	3.4	.1	30	25.7	.7	14.6	43.1	15.9	13.0	95.7
IIIBC	34-54	5.8	nd	nd	5.9	nd	nd	14.6	1.2	1.2	67.3	15.7	15.6	99.6
IIIC	54+	6.2	nd	nd	6.6	nd	nd	7.5	2.0	1.0	78.1	11.4	17.9	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	11-0	nd	nd	nd	nd	nd	nd	nd	nd	137.4	63.5	34.5	29.0	4.62	.06	.00	.06
Bm	0-4	11	5	67	28	8	nd	nd	nd	31.0	20.9	8.9	12.0	1.57	.08	.00	.08
IIAhej	4-14	3	14	56	30	9	nd	nd	nd	34.5	22.8	10.9	11.9	2.12	.11	.01	.12
IIAej	14-19	9	13	60	27	8	nd	nd	nd	23.1	18.6	7.2	11.4	1.3	.09	.00	.09
IIIBfj	19-34	30	14	56	30	7	nd	nd	nd	21.3	16.9	6.9	10.0	1.2	.07	.00	.07
IIIBC	34-54	31	14	57	29	7	nd	nd	nd	21.2	17.1	7.8	9.3	1.5	.07	.02	.09
IIIC	54+	36	14	56	30	7	nd	nd	nd	24.9	16.5	8.1	8.4	1.7	.07	.01	.08

Sub-group:........................ Degraded Eutric Brunisol.

Profile number:.................. M8.

Location:......................... Near Forestry Plot #79.

Vegetation: Tree canopy......... *Picea* sp..

Shrub:.............. ---

Ground:............. Moss, *Linnaea* sp., *Pyrola* sp..

Parent material:................. Colluvium/Till I.

Topography:...................... Very steeply sloping; aspect N.

Elevation:....................... 5800 ft. M.S.L..

Drainage:........................ Well.

Horizon	Depth (cm)	Description
L - H	16 - 0	Organic material in various stages of decomposition.
Aej	0 - 5	Brown (7.5 YR 4/2-4/4) silt loam, pale brown (10 YR 6/3) when dry; weak, coarse granular; friable; pH 6.3; abrupt, smooth boundary.
Bfj	5 - 7	Dark reddish brown (5 YR 3/4) silt loam, brown (10 YR 5/3) when dry; weak, medium granular; friable; abrupt, broken boundary.
IIBC	7 - 10	Dark grayish brown (10 YR 4/2) loam, grayish brown to brown (10 YR 5/2-5/3) when dry; weak, fine granular; friable; pH 7.2; very angular gravelly; gradual, smooth boundary.
IIC	10 - 84 +	Very dark grayish brown (10 YR 3/2)

Horizon	Depth (cm)	Description
IIC	10 - 84 +	loam, gray to grayish brown (10 YR 5/1-5/2) when dry; amorphous; friable; pH 7.6; strong effervescent; very angular gravelly to exceedingly cobbly.

Sub-group: Degraded Eutric Brunisol Profile No. M8.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	16-0	4.6	nd	nd	40.4	1.0	39	47.3	.9	2.0	43.5	6.3	97.5	nd
Aej	0-5	6.3	nd	nd	5.7	.2	37	6.0	.6	.6	84.2	8.5	23.9	nd
Bfj	5-7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
IIBC	7-10	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
IIC	10-64+	7.6	16.2	nd	nd	nd	nd	nd	.6	4.5	91.6	3.3	6.1	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	16-0	nd	nd	nd	nd	nd	nd	nd	nd	412.3	128.8	72.6	56.2	9.38	.03	.00	.03
Aej	0-5	14	32	50	18	7	.50	79.8	160	39.4	28.1	11.7	16.4	2.06	.07	.00	.07
Bfj	5-7	0	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
IIBC	7-10	0	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
IIC	10-64+	36	34	46	20	7	.95	64.2	67	16.9	13.9	8.3	8.3	.64	.04	.00	.04

Sub-group: .... Orthic Ferro-Humic Podzol.

Profile number:.................. M9.

Location:........................ Near Forestry Plot # 204.

Vegetation: Tree canopy:......... _Picea_ sp..

Understory:.......... _Menziesia_ sp..

Ground:.............. Moss, _Pyrola_ sp. _Cornus_ sp., _Vaccinium_ sp..

Parent material:................. Colluvium/Colluvium & Aeolian/ Aeolian/Till I.

Topography:...................... Steeply sloping; aspect S.S.W..

Elevation:....................... 5860 ft. M.S.L..

Drainage:........................ Moderately well.

Horizon	Depth (cm)	Description
L - H	17 - 0	Organic material in various stages of decomposition.
Ae	0 - 4	Gray to light gray (2.5 Y 6/0-7/0) silt loam, white (2.5 Y 8/0) when dry; strong coarse platy; friable; pH 4.3; abrupt, wavy boundary.
IIBfh	4 - 8	Yellowish red (5 YR 4/8) silt loam, light yellowish brown (10 YR 6/4) when dry; weak, coarse platy breaking to strong, medium granular; friable; pH 5.4; gradual, wavy boundary.
IIIBf1	8 - 18	Reddish yellow (7.5 YR 6/8) silt loam, very pale brown to yellow (10 YR 7/4-7/6) when dry; strong, coarse

Horizon	Depth (cm)	Description
IIIBf1	8 - 18	platy breaking to strong, medium granular; friable; pH 6.1; abrupt, smooth boundary.
IVBf2	18 - 40	Pinkish gray (7.5 YR 6/2) silt loam light gray to very pale brown (10 YR 7/3-7/3) when dry; weak, medium sub-angular blocky; friable; pH 5.9; moderately angular flaggy; abrupt, smooth boundary.
IVBC	40 - 50	Brown to pale brown (10 YR 5/3-6/3) silt loam, light gray (10 YR 7/2) when dry; amorphous; friable; slightly angular gravelly; pH 6.0; clear, smooth boundary.
IVC	50 - 85 +	Dark brown to brown (10 YR 4/3) silt loam, light gray (10 YR 7/2) when dry; amorphous; friable; pH 5.8; moderately angular gravelly.

Sub-group: Orthic Ferro-Humic Podzol Profile No. M9.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	17-0	4.2	nd	nd	42.6	.71	60	36.5	.7	6.8	43.5	12.5	89.2	nd
Ae	0-4	4.3	nd	nd	2.6	.07	35	60.9	1.4	2.2	25.4	10.1	15.3	nd
IIBfh	4-8	5.4	nd	nd	2.8	.13	22	54.1	1.4	4.8	32.9	6.8	25.9	nd
IIIBf1	8-18	6.1	nd	nd	1.7	.07	24	43.3	2.2	6.7	43.3	4.5	14.5	nd
IVBf2	18-40	5.9	.36	nd	1.3	nd	nd	13.3	2.0	3.1	75.5	6.1	9.4	nd
IVBC	40-50	6.0	.00	nd	2.0	nd	nd	11.0	7.9	1.6	67.7	11.8	10.4	nd
IVC	50-65+	5.8	nd	nd	1.2	nd	nd	10.2	2.4	1.6	72.4	13.4	10.7	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	17-0	0	nd	nd	nd	nd	nd	nd	nd	281.1	108.0	81.7	27.4	7.0	.03	.03	.06
Ae	0-4	2	20	61	19	7	.69	72.2	105	nd	29.0	6.7	23.4	1.4	.04	.04	.08
IIBfh	4-8	6	20	55	25	9	.69	71.1	103	nd	35.0	13.8	21.2	4.1	.42	.83	1.25
IIIBf1	8-18	0	21	69	10	5	1.26	46.2	37	nd	42.6	11.8	30.8	3.7	.24	1.08	1.32
IVBf2	18-40	9	23	59	18	5	1.28	52.2	41	nd	20.4	4.8	16.6	1.1	.16	.03	.19
IVBC	40-50	4	18	64	18	5	1.49	43.3	29	nd	21.6	4.7	17.8	1.1	.09	.02	.11
IVC	50-65	20	21	58	21	9	1.46	44.3	30	nd	20.8	6.2	14.6	1.3	.10	.03	.13

Sub-group:....................Orthic Dystric Brunisol/Orthic Ferro-Humic Podzol.

Profile number:.................. M10.

Location:...................... Near Forestry Plot #170.

Vegetation: Tree canopy:......... *Picea* sp., *Abies* sp..

Understory:.......... *Menziesia* sp., *Ribes* sp., *Lonicera* sp..

Ground:............. *Vaccinium* sp., *Linnaea* sp., Moss.

Parent material:................ Colluvium/Colluvium/Till I.

Topography:..................... Steeply sloping; aspect E.S.E..

Elevation:...................... 5850 ft. M.S.L..

Drainage:....................... Moderately well.

Horizon	Depth (cm)	Description
L - H	8 - 0	Organic material in various stages of decomposition.
Bm1	0 - 14	Grayish brown to brown (10 YR 5/2-5/3) silty clay loam, light brownish gray to pale brown (10 YR 6/2-6/3) when dry; weak, medium subangular blocky; friable; pH 4.7; slightly angular gravelly; abrupt, wavy boundary.
IIBm2	14 - 21	Yellowish brown (10 YR 5/4) clay loam, light brownish gray (10 YR 6/2) when dry; weak, medium subangular blocky; friable; pH 5.3; moderately angular gravelly; abrupt, wavy boundary.
IIIAeb	21 - 25	Pinkish gray to light reddish brown

Horizon	Depth (cm)	Description
IIIAeb	21 - 25	(5 YR 6/2-6/3) silt loam, very pale brown (10 YR 7/3) when dry; weak, medium subangular blocky breaking to weak, coarse platy; friable; pH 5.0; slightly angular gravelly; clear, wavy boundary.
IIIBfb	25 - 41	Yellowish red (5 YR 5/8) silty clay loam, light yellowish brown to very pale brown (10 YR 6/4-7/4) when dry; strong, coarse granular; friable; pH 6.4; slightly angular gravelly; clear, wavy boundary.
IIIBCb	41 - 60	Brown (10 YR 5/3) silt loam, very pale brown (10 YR 7/3) when dry; weak, medium subangular blocky; friable; pH6.5; moderately angular gravelly; gradual, wavy boundary.
IIIC	60 - 85 +	Gray to grayish brown (10 YR 5/1-5/2) silt loam, light brownish gray (10 YR 6/2) when dry; amorphous, friable; pH 6.6; moderately, angular gravelly.

Sub-group: Orthic Dystric Brunisol/Orthic Ferro-Humic Podzol Profile No. M10.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	8-0	4.7	nd	nd	36.7	1.0	35	32.5	1.2	4.5	49.6	12.2	79.3	nd
Bm1	0-14	4.7	nd	nd	3.3	.1	32	54.2	1.3	1.9	31.8	10.8	17.2	95.7
IIBm2	14-21	5.3	nd	nd	2.4	.1	25	29.0	1.6	1.6	57.4	10.4	19.2	95.1
IIIAeb	21-25	5.9	nd	nd	2.2	.1	25	17.5	1.3	1.9	68.3	11.0	15.3	99.7
IIIBfb	25-41	6.4	nd	nd	2.5	.1	19	19.2	1.9	2.8	69.0	7.1	30.0	nd
IIIBCb	41-60	6.5	nd	nd	2.3	.1	nd	15.7	2.2	1.5	79.1	1.5	19.9	nd
IIIC	60-85+	6.6	nd	nd	3.2	.1	nd	10.9	1.7	1.7	74.2	11.5	13.0	nd

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	8-0	0	nd	nd	nd	nd	nd	nd	nd	253.4	118.5	81.4	37.1	7.1	.03	.00	.03
Bm1	0-14	37	17	55	28	10	.98	60.3	62	27.2	23.8	8.6	15.2	2.0	.14	.21	.35
IIBm2	14-21	24	23	49	28	11	.92	63.2	69	25.5	23.4	8.7	14.7	1.9	.15	.06	.21
IIIAeb	21-25	13	17	59	24	9	1.05	58.2	55	26.9	25.9	7.9	18.0	1.5	.15	.00	.15
IIIBfb	25-41	3	15	50	35	15	.96	61.0	63	63.5	52.8	20.1	32.7	4.2	.40	.73	1.13
IIIBCb	41-60	24	18	64	18	6	1.27	52.6	42	24.9	21.0	5.5	15.5	1.1	.05	.00	.05
IIIC	60-85+	28	20	58	22	7	1.57	40.8	26	20.2	20.5	7.2	13.3	1.3	.06	.02	.08

Sub-group:...................... Orthic Gray Luvisol.

Profile number:................. M11.

Location:....................... Near Forestry Plot # 23.

Vegetation: Tree canopy:......... *Pinus contorta*, Picea sp..

Understory:.......... *Rosa* sp..

Ground:............. *Festuca* sp., *Castillejo* sp., *Galium* sp., *Fragaria* sp..

Parent material:................ Colluvium/Till I, compacted phase.

Topography:..................... Strongly sloping; aspect S.W..

Elevation:...................... 5775 ft. M.S.L.

Drainage:....................... Well.

Horizon	Depth (cm)	Description
L - H	1 - 0	Organic material in various stages of decomposition.
Ah	0 - 3	Black (10 YR 2/1) silt loam, dark gray (10 YR 4/1) when dry; strong, medium granular; friable; pH 7.1; abrupt, wavy boundary.
Ae	3 - 12	Dark brown (7.5 YR 4/2) silty clay loam, brown (10 YR 5/3) when dry; weak, medium subangular blocky breaking to weak, coarse platy; friable; pH 7.0; slightly angular cobbly; clear, wavy boundary.
IIBt	12 - 25	Dark yellowish brown (10 YR 3/4-4/4) silty clay, dark brown (10 YR 4/3) when dry; strong, coarse subangular

Horizon	Depth (cm)	Description
IIBt	12 - 25	blocky; firm, pH 7.1; moderately to very angular cobbly; clear, smooth boundary.
IIBC	25 - 32	Dark brown (10 YR 3/3) silty clay loam, very dark grayish brown to dark brown, (10 YR 3/2-3/3) when dry; weak, medium granular; firm; pH 7.7; moderately to very angular cobbly; clear, smooth boundary.
IIC	32 - 94 +	Dark gray to dark grayish brown (10 YR 4/1-4/3) silt loam, grayish brown (10 YR 5/3) when dry; amorphous; friable; pH 7.9; strong effervescence; moderately angular gravelly.

Sub-group: Orthic Gray Luvisol

Profile No. M11

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	1-0	7.1	nd	nd	22.9	1.27	18	nd	.3	3.9	77.2	18.6	49.8	nd
Ah	0-3	7.1	nd	nd	11.6	.61	19	nd	1.0	2.5	83.4	13.1	40.8	nd
Ae	3-12	7.0	nd	nd	2.4	.1	18	nd	1.2	1.2	81.7	15.9	12.0	nd
IIBt	12-25	7.1	nd	nd	2.3	.2	15	nd	.9	1.3	78.4	19.4	24.3	nd
IIBC	25-32	7.7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
IIC	32-94+	7.9	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	1-0	nd	nd	nd	nd	nd	nd	nd	nd	189.3	83.9	68.7	15.2	5.7	nd	nd	nd
Ah	0-3	8	21	53	26	13	nd	nd	nd	78.8	45.4	22.2	23.2	3.9	nd	nd	nd
Ae	3-12	17	20	50	30	17	nd	nd	nd	36.1	23.1	11.8	11.3	2.3	nd	nd	nd
IIBt	12-25	18	12	45	43	23	nd	nd	nd	43.8	25.4	16.0	9.4	3.1	nd	nd	nd
IIBC	25-32	54	12	52	36	23	nd	nd	nd	43.4	26.0	13.5	12.5	2.3	nd	nd	nd
IIC	32-94	32	23	52	25	13	nd	nd	nd	57.2	38.8	20.6	18.2	1.8	nd	nd	nd

Sub-group: .... Mini Ferro-Humic Podzol.

Profile number:.................. M12.

Location:........................ Near Forestry Plot # 309.

Vegetation: Tree canopy:......... _Picea_ sp., _Pinus contorta_, _Abies_ sp..

Understory:.......... _Menziesia_ sp..

Ground:.............. Moss, _Vaccinium scoparium_.

Parent material:................. Colluvium/Aeolian/Till I.

Topography:...................... Moderately sloping; aspect E..

Elevation:....................... 6200 ft. M.S.L..

Drainage:........................ Well.

Horizon	Depth (cm)	Description
L - H	5 - 0	Organic material in various stages of decomposition.
Ae	0 - 4	Gray to light brownish gray (10 YR 4/1-4/2) silt loam, light gray to white (10 YR 7/2-8/2) when dry; strong, coarse platy; friable; pH 4.5; abrupt, wavy boundary.
IIBf1	4 - 9	Yellowish red (5 YR 4/8) silt loam, very pale brown to yellow (10 YR 7/4-7/6) when dry; strong, coarse platy breaking to strong, medium granular; friable; pH 5.7; slightly to moderately angular gravelly; clear, wavy boundary.
IIIBf2	9 - 26	Brown to light brown (7.5 YR 5/4-6/4) silt loam, light gray to very pale brown (10 YR 7/2-7/3) when dry; strong,

Horizon	Depth (cm)	Description
IIIBf2	9 - 26	medium granular; friable; pH 5.3; moderately to very angular gravelly; gradual, smooth boundary.
IIIBC	26 - 46	Dark grayish brown (10 YR 4/2) loam, pale brown to very pale brown (10 YR 6/3-7/3) when dry; amorphous to single grained; friable; pH 5.5; exceedingly angular gravelly; clear, smooth boundary.
IIIC	46 - 68 +	Very dark gray to dark gray (10 YR 3/1-4/1) loam, dark grayish brown to grayish brown (10 YR 4/2-5/2) when dry; amorphous; friable; pH 6.7; very angular gravelly.

Sub-group: Mini Ferro-Humic Podzol   Profile No. M12.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	5-0	4.5	nd	nd	37.7	.9	41	54.9	.5	6.5	27.5	10.6	69.8	nd
Ae	0-4	4.5	nd	nd	2.0	.1	23	68.8	1.1	2.3	21.0	6.8	16.2	95.7
IIBf1	4-9	5.7	nd	nd	1.7	.1	15	63.6	3.0	5.1	25.0	3.0	21.9	98.7
IIIBf2	9-26	5.3	nd	nd	1.1	nd	27	53.2	3.2	3.2	36.2	4.3	9.0	94.5
IIIBC	26-46	5.5	nd	nd	.6	nd	nd	13.5	3.4	1.3	66.2	15.6	10.3	99.0
IIIC	46-68+	6.7	nd	nd	1.6	nd	nd	2.2	.9	.7	91.4	4.8	15.1	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	5-0	0	nd	nd	nd	nd	nd	nd	nd	207.3	112.4	77.0	35.4	6.50	.05	.00	.05
Ae	0-4	3	19	63	18	6	.73	72.2	95	50.0	32.9	9.4	23.5	1.8	.05	.06	.11
IIBf1	4-9	11	20	63	17	6	.60	72.7	122	57.5	47.7	16.0	31.7	5.2	.38	1.20	1.58
IIIBf2	9-26	50	23	58	19	5	.97	62.3	64	22.1	18.9	5.7	13.2	1.0	.15	.06	.21
IIIBC	26-46	64	33	45	22	6	.92	65.0	71	18.4	11.8	6.6	5.2	1.2	.14	.04	.18
IIIC	46-68+	42	31	43	26	12	.87	67.8	78	25.1	21.1	10.5	10.6	1.7	.15	.06	.21

Sub-group: .... Brunisolic Gray Luvisol.

Profile number: .... M 13.

Location: .... Near Forestry Plot #144.

Vegetation: Tree Canopy: .... <u>Pinus contorta</u>, <u>Abies</u> sp., <u>Picea</u> sp..

Understory: .... <u>Ledum</u> sp..

Ground: .... <u>Vaccinium scoparium</u>, moss, <u>Cornus</u> sp..

Parent material: .... Aeolian Colluvium/Till 1, compacted phase.

Topography: .... Strongly sloping; aspect S..

Elevation: .... 6095 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	3 - 0	Organic material in various stages of decomposition.
(Ae)	0 - 4	Grayish brown (10 YR 5/2) silt loam, light gray to white (10 YR 7/2-8/2) when dry; weak, coarse platy; friable; pH 5.1; slightly angular gravelly; abrupt, wavy boundary.
(Bf)	4 - 10	Yellowish red (5 YR 4/6-5/6) silt loam, light yellowish brown (10 YR 6/4) when dry; weak, coarse platy breaking to weak, medium granular; friable; pH 5.4; moderately angular gravelly; clear, wavy boundary.
IIAe	10 - 15	Light yellowish brown (10 YR 6/4) silt

Horizon	Depth (cm)	Description
IIAe	10 - 15	loam, very pale brown (10 YR 7/3) when dry; weak, coarse platy; friable; pH 5.4; moderately angular gravelly; gradual, wavy boundary.
IIAB	15 - 28	Light yellowish brown (10 YR 6/4) silt loam, pale brown to light yellowish brown (10 YR 6/3-6/4) when dry; weak, medium subangular blocky; friable; pH 6.1; moderately angular gravelly; clear, wavy boundary.
IIBt	28 - 38	Yellowish brown (10 YR 5/4) silt loam, brown (10 YR 5/3) when dry; weak, medium subangular blocky; firm; pH 6.2; very angular gravelly; clear, smooth boundary.
IIBC	38 - 52	Dark grayish brown (10 YR 4/2) clay loam, dark grayish brown to dark brown (10 YR 4/2-4/3) when dry; weak, medium subangular blocky; firm; pH 6.6; moderately angular gravelly; gradual, smooth boundary.
IIC	52 - 81 +	Very dark gray (10 YR 3/1) silt loam, dark brown (10 YR 4/3) when dry; amorphous; friable; pH 7.6; strong effervescence; very angular gravelly to angular cobbly.

Sub-group: Brunisolic Gray Luvisol

Profile No. M13

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	3-0	5.2	nd	nd	37.7	1.3	29	42.6	.7	.4	41.6	14.7	73.4	nd
(Ae)	0-4	5.1	nd	nd	2.2	.1	19	41.7	3.6	8.6	35.3	10.8	11.8	nd
(Bf)	4-10	5.4	nd	nd	2.7	.1	26	47.9	.6	8.0	33.7	9.8	18.4	nd
IIAe	10-15	5.4	nd	nd	1.1	.0	26	38.0	2.8	4.6	41.6	13.0	9.1	nd
IIAB	15-28	6.1	nd	nd	.5	.0	15	21.7	.8	3.3	45.8	28.4	9.1	nd
IIBt	28-38	6.2	nd	nd	1.0	.1	19	13.5	1.2	1.8	62.4	21.2	12.3	nd
IIBC	38-52	6.4	nd	nd	1.0	nd	nd	7.9	.9	1.9	65.1	24.2	15.3	nd
IIC	52-81+	7.6	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	3-0	nd	nd	nd	nd	nd	nd	nd	nd	248.1	122.6	97.8	24.8	7.2	nd	nd	nd
(Ae)	0-4	3	21	67	12	3	1.01	60.4	60	33.6	25.4	7.9	17.5	1.2	nd	nd	nd
(Bf)	4-10	8	25	55	20	7	1.01	59.8	59	43.5	27.9	13.4	14.5	2.6	nd	nd	nd
IIAe	10-15	11	29	59	12	3	1.24	53.4	43	20.7	18.4	5.5	12.9	1.1	nd	nd	nd
IIAB	15-28	5	29	54	17	12	1.24	53.6	43	20.1	15.7	8.9	6.8	1.5	nd	nd	nd
IIBt	28-38	39	20	53	27	11	1.13	58.0	52	24.8	18.1	7.7	10.4	1.8	nd	nd	nd
IIBC	38-52	9	26	44	30	14	1.08	59.6	55	27.4	21.7	10.8	10.9	1.2	nd	nd	nd
IIC	52-81+	35	23	55	22	9	1.30	51.3	39	26.2	18.0	6.9	11.1	nd	nd	nd	nd

Sub-group: .... Orthic Eutric Brunisol.

Profile number: .... M 14.

Location: .... Near Forestry Plot #101.

Vegetation: Tree Canopy: .... Picea sp., Abies sp..

Understory: .... Ledum sp., Ribes sp..

Ground: .... Moss, Linnaea sp., Equisetum sp..

Parent material: .... Colluvium/Aeolian Colluvium/Till 1.

Topography: .... Strongly sloping; aspect ESE.

Elevation: .... 6080 ft. M.S.L..

Drainage: .... Imperfect.

Horizon	Depth (cm)	Description
L - H	10 - 0	Organic material in various stages of decomposition.
Bm	0 - 15	Dark grayish brown (10 YR 4/2) silt loam, brown (10 YR 5/3) when dry; strong, coarse granular; friable; pH 6.8; moderately angular gravelly; abrupt, smooth boundary.
IIAhb	15 - 23	Black (10 YR 2/1) silt loam, very dark grayish brown (10 YR 3/2) when dry; weak, medium prismatic breaking to strong, coarse granular; friable; pH 6.9; moderately angular gravelly; clear, wavy boundary.
IIBfhb	23 - 36	Dark brown to dark yellowish brown (10 YR 3/3-3/4) silt loam, yellowish brown (10 YR 5/4) when dry; weak medium subangular

Horizon	Depth (cm)	Description
IIBfhb	23 - 36	blocky, friable; pH 7.3; moderately angular gravelly; clear, smooth boundary.
IIIBmb	36 - 44	Brown (10 YR 5/3) silt loam, yellowish brown (10 YR 5/4) when dry; weak, medium subangular blocky; friable; pH 7.2; slight effervescence; moderately angular gravelly; clear, smooth boundary.
IIIBCb	44 - 62	Dark brown to brown (10 YR 4/3) loam, grayish brown (10 YR 5/2) when dry; moderate, coarse granular; friable; pH 7.3; slight effervescence; moderately angular gravelly; clear, wavy boundary.
IIIC	62 - 86 +	Very dark gray (10 YR 3/1) silt loam, brown (10 YR 4/2) when dry; amorphous; friable; pH 7.6; strong effervescence; moderately angular gravelly.

Sub-group: Orthic Eutric Brunisol

Profile No. M14

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	10-0	5.9	nd	nd	39.1	1.0	38	20.6	.4	1.4	67.6	10.0	122.5	nd
Bm	0-15	6.8	nd	nd	3.0	.2	15	7.3	.6	.9	71.6	19.6	28.9	nd
IIAhb	15-23	6.9	nd	nd	14.0	.8	17	5.4	.4	.5	84.2	9.5	77.9	nd
IIBfhb	23-36	7.3	nd	nd	3.7	.2	17	nd	.9	1.7	90.1	7.3	59.0	nd
IIIBmb	36-44	7.2	nd	nd	1.6	.1	21	nd	1.1	1.6	88.3	9.0	14.6	nd
IIIBCb	44-62	7.3	nd	nd	nd	nd	nd	nd	.5	1.6	79.9	18.0	15.0	nd
IIIC	62.86	7.6	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L - H	10-0	nd	nd	nd	nd	nd	nd	nd	nd	293.0	134.6	87.4	47.2	12.2	.05	.00	.05
Bm	0-15	28	31	50	19	6	.50	79.4	159	46.8	32.5	13.4	29.1	2.6	.12	.12	.24
IIAhb	15.23	7	16	62	22	5	.66	66.3	101	133.7	81.6	39.6	42.0	7.6	.17	.11	.28
IIBfhb	23-36	13	24	57	19	6	1.00	58.0	58	62.9	37.4	14.8	22.6	3.5	.15	.00	.15
IIIBmB	36-44	42	27	52	21	10	1.15	55.9	49	26.3	18.3	8.9	9.4	1.6	.09	.00	.09
IIIBCb	44-62	35	27	46	27	15	1.03	61.6	60	nd	20.1	10.0	10.1	1.7	.10	.00	.10
IIIC	62-86	33	21	54	25	12	1.39	48.1	nd	25.6	20.6	8.6	12.0	1.3	.08	.01	.09

Sub-group: .... Mini Ferro-Humic Podzol.

Profile number: .... M 15.

Location: .... Between Forestry Plots #153 and #154.

Vegetation: Tree canopy: .... *Picea* sp., *Abies* sp..

Understory: .... *Menziesia* sp..

Ground: .... Moss, *Vaccinium scoparium*, *Lycopodium* sp..

Parent material: .... Colluvium/Aeolian/Till 1.

Topography: .... Steeply sloping; aspect NNW.

Elevation: .... 6140 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	7 - 0	Organic material in various stages of decomposition.
Ae	0 - 4	Light brownish gray (10 YR 6/2) silt loam, light gray to white (10 YR 7/2-8/2) when dry; strong, coarse platy; friable; pH 4.4; clear, smooth boundary.
IIBf1	4 - 14	Yellowish red (5 YR 4/6) silt loam, yellow when dry (10 YR 7/6), strong, coarse platy breaking to strong medium granular; friable; pH 5.5; clear, smooth boundary.
IIIBf2	14 - 27	Light yellowish brown (10 YR 6/4) silt loam, very pale brown (10 YR 7/3) when dry; weak, coarse platy breaking to strong, coarse granular; friable; pH 5.3; moderately to very angular cobbly; gradual, wavy boundary.

Horizon	Depth (cm)	Description
IIIBC	27 - 42	Dark grayish brown (10 YR 4/2) silt loam, light gray (10 YR 7/2) when dry; weak, medium subangular blocky; friable; pH 5.8; moderately to very angular cobbly; gradual, wavy boundary.
IIIC	42 - 71 +	Black to very dark gray (10 YR 2/1-3/1) silt loam, gray (10 YR 5/1) when dry; amorphous; friable; pH 6.5; moderately to very angular cobbly.

Sub-group: Mini Ferro-Humic Podzol — Profile No. M15

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L - H	7-0	4.7	nd	nd	37.9	1.09	35	55.7	.6	3.1	33.2	7.4	98.2	nd
Ae	0-4	4.4	nd	nd	4.73	.15	31	68.2	.5	3.7	20.6	7.0	18.9	95.6
IIBf1	4-14	5.5	nd	nd	5.63	.22	26	69.9	.6	4.6	21.4	3.5	36.5	88.2
IIIBf2	14-27	5.3	nd	nd	1.39	.05	29	46.0	2.0	2.0	41.0	9.0	7.4	95.3
IIIBC	27-42	5.8	nd	nd	1.9	nd	nd	17.6	1.3	1.9	59.7	19.5	11.4	99.8
IIIC	42-71+	6.5	nd	nd	2.4	nd	nd	5.8	2.6	1.6	80.1	9.9	14.5	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L - H	7-0	nd	nd	nd	nd	nd	nd	nd	nd	476.2	129.8	99.5	30.3	7.8	.05	.0	.05
Ae	0-4	5	18	61	21	8	.67	71.4	106	58.6	41.0	11.2	29.8	2.1	.05	.0	.05
IIBf1	4.-14	9	17	64	19	6	.50	76.2	153	75.4	62.4	22.3	40.1	7.4	.40	1.30	1.70
IIIBf2	14-27	31	28	59	13	3	.92	63.8	70	20.5	23.1	5.0	18.1	1.1	.10	.01	.11
IIIBC	27-42	22	27	52	21	6	1.08	58.3	54	24.2	25.0	7.7	17.3	1.3	.13	.06	.19
IIIC	42-71+	30	26	53	21	10	1.00	62.4	62	25.8	24.7	8.6	16.1	1.4	.11	.02	.13

Sub-group: .... Mini Ferro-Humic Podzol.

Profile number: .... M 16.

Location: .... South of Forestry Plot #159.

Vegetation: Tree canopy: .... _Picea_ sp., _Abies_ sp..

Understory: .... _Menziesia_ sp..

Ground: .... Moss, _Vaccinium_ sp., _Cornus_ sp., _Lycopodium_ sp..

Parent material: .... Colluvium/Aeolian/Till 1.

Topography: .... Strongly sloping; aspect ENE.

Elevation: .... 5850 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	12 - 0	Organic material in various stages of decomposition.
Ae	0 - 6	Pinkish gray (7.5 YR 6/2) silt loam, light brownish gray (10 YR 6/2) when dry; strong coarse platy; friable; pH 5.5; clear, wavy boundary.
IIBf1	6 - 14	Yellowish red (5 YR 4/6-4/8) silt loam, brown (10 YR 5/3) when dry; strong coarse platy breaking to strong, medium granular; friable; pH 6.1; clear, wavy boundary.
IIIBf2	14 - 25	Light brown (7.5 YR 6/4) silt loam, very pale brown (10 YR 7/3) when dry; strong, coarse granular; friable; pH 6.0; moderately angular cobbly; gradual, smooth

Horizon	Depth (cm)	Description
IIIBf2	14 - 25	boundary.
IIIBC	25 - 38	Dark gray to very dark grayish brown (10 YR 4/1 - 3/2) clay loam, grayish brown to light brownish gray (10 YR 5/2 - 6/2) when dry; weak, medium granular to amorphous; firm; pH 6.2; moderately angular cobbly; gradual, smooth boundary.
IIIC	38 - 66 +	Very dark gray (10 YR 3/1) clay loam to silty clay loam, dark gray (10 YR 4/1) when dry; amorphous; firm; pH 7.6; strong effervescence; moderately angular cobbly.

Sub-group: Mini Ferro-Humic Podzol   Profile No. M16.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	12-0	4.6	nd	nd	31.5	.9	34	46.3	.2	1.9	41.5	10.1	88.5	nd
Ae	0-6	5.5	nd	nd	2.6	.1	25	25.4	3.2	2.1	51.3	18.0	17.8	98.4
IIBf1	6-14	6.1	nd	nd	2.2	.1	15	24.4	1.6	2.4	52.6	19.0	34.2	99.6
IIIBf2	14-25	6.0	nd	nd	1.4	.1	28	10.6	1.9	1.9	55.6	30.0	11.1	nd
IIIBC	25-38	6.2	nd	nd	1.5	nd	nd	7.5	2.5	1.5	76.4	12.1	14.5	nd
IIIC	38-66+	7.6	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	12-0	0	nd	nd	nd	nd	nd	nd	nd	274.1	104.1	72.9	31.2	8.38	.07	.03	.1
Ae	0-6	2	16	65	19	6	.65	72.7	112	54.9	40.0	10.1	29.9	2.08	.07	.05	.12
IIBf1	6-14	3	17	56	27	7	.60	74.5	124	66.7	57.0	24.0	33.0	5.58	.32	1.00	1.32
IIIBf2	14-25	33	15	62	23	7	1.07	59.5	56	21.7	22.6	6.5	16.1	1.22	.12	.05	.17
IIIBC	25-38	38	21	46	33	12	1.08	59.2	55	24.5	20.9	10.4	10.5	1.86	.13	.06	.19
IIIC	38-66+	26	20	46	34	15	1.33	49.8	57	28.3	21.8	12.7	9.1	2.11	.09	.06	.15

Sub-group: .... Orthic Gray Luvisol.

Profile number: .... M 17.

Location: .... Near Forestry Plot #16.

Vegetation: Tree canopy: .... Pinus sp., Picea sp..

Understory: .... Rosa sp..

Ground: .... Aster sp., Epilobrium sp..

Parent material: .... Till 1/Colluvium.

Topography: .... Steeply sloping; aspect S.E..

Elevation: .... 5840 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	3 - 0	Organic material in various stages of decomposition.
Ae1	0 - 8	Reddish brown (5 YR 5/3-5/4) silt loam, pale brown (10 YR 6/3) when dry; weak, medium platy; friable; pH 6.9; exceedingly angular gravelly to cobbly; gradual, wavy boundary.
Ae2	8 - 22	Brown (7.5 YR 5/4) silt loam, pale brown to very pale brown (10 YR 6/3-7/3) when dry; strong, coarse granular; friable; pH 7.1; exceedingly angular gravelly to cobbly; diffuse, wavy boundary.
Bt1	22 - 36	Dark brown to brown (7.5 YR 4/4-5/4) silty clay loam, light yellowish brown (10 YR 6/4) when dry; strong, medium sub-

Horizon	Depth (cm)	Description
Bt1	22 - 36	angular blocky; firm; pH 6.7; exceedingly angular gravelly to cobbly; gradual, wavy boundary.
Bt2	36 - 47	Dark brown to brown (7.5 YR 4/4) silty clay loam, yellowish brown (10 YR 5/4) when dry; strong, medium subangular blocky; firm; pH 6.8; exceedingly angular gravelly to cobbly; clear, wavy boundary.
BC	47 - 53	Very dark grayish brown to dark grayish brown (10 YR 3/2-4/2) silt loam, dark brown to brown (10 YR 4/3) when dry; weak, medium subangular blocky; friable; pH 7.7; exceedingly angular flaggy to cobbly; gradual smooth boundary.
C	53 - 68 +	Dark gray to very dark grayish brown (10 YR 4/1-3/2) silt loam, dark gray (10 YR 4/1) when dry; amorphous; friable; pH 8.0; exceedingly angular gravelly to cobbly.

Sub-groupL Orthic Gray Luvisol

Profile No. M17

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L - H	3-0	6.4	nd	nd	33.3	.75	44	3.9	.5	5.5	76.0	14.1	66.5	nd
Ae1	0-8	6.9	nd	nd	2.0	.1	27	9.9	1.2	5.5	79.0	4.4	13.9	nd
Ae2	8-22	7.1	nd	nd	1.3	.1	25	nd	2.0	.5	85.7	11.8	11.1	nd
Bt1	22-36	6.7	nd	nd	1.0	.1	16	1.5	.5	.4	85.8	11.8	17.0	nd
Bt2	36-47	6.8	nd	nd	1.1	.1	17	1.3	.4	.4	83.5	14.4	19.6	nd
BC	47-53	7.7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
C	53-68+	8.0	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	3-0	nd	nd	nd	nd	nd	nd	nd	nd	205.1	78.0	44.3	33.7	6.6	nd	nd	nd
Ae1	0-8	33	26	59	15	5	1.03	60.1	58	34.0	24.9	7.6	17.3	1.5	nd	nd	nd
Ae2	8-22	34	21	61	18	6	1.03	61.0	59	24.5	21.5	6.9	14.6	1.2	nd	nd	nd
Bt1	22-36	36	17	54	29	12	nd	nd	nd	28.2	23.4	11.0	10.2	1.9	nd	nd	nd
Bt2	36-47	26	16	56	28	11	.93	64.8	70	31.1	22.5	11.6	11.8	2.2	nd	nd	nd
BC	47-53	33	19	60	21	6	.91	65.5	92	33.6	17.2	9.0	13.5	1.8	nd	nd	nd
C	53-68+	30	23	55	22	9	.83	68.8	82	26.5	nd	6.2	11.0	1.1	nd	nd	nd

Sub-group: .... Carbonated Rego Gleysol.

Profile number: .... M 18.

Location: .... 3/8 mile North of Marmot Creek lower Stream Gauge.

Vegetation: Tree canopy: .... *Picea* sp..

Understory: .... *Betula* sp., *Potentilla* sp., *Salix* sp..

Ground: .... *Carix* sp., *Juncus* sp., *Orchidaceae* sp..

Parent material: .... Colluvium.

Topography: .... Moderately to strongly sloping; aspect ESE.

Elevation: .... 5290 ft. M.S.L..

Drainage: .... Very poor.

Horizon	Depth (cm)	Description
L - H	6 - 0	Organic material in various stages of decomposition.
AC	0 - 12	Gray (5 YR 5/1) clay, white (10 YR 8/1) when dry; amorphous; very sticky; pH 7.0; clear, smooth boundary.
Cca	12 - 26	Light olive gray to pale yellow (5 YR 6/2-7/3) clay, white (10 YR 8/1) when dry; amorphous; very sticky; pH 7.7; abrupt, smooth boundary.
C	26 - 40	Olive gray (5 YR 5/2) silty clay loam, gray to light gray (10 YR 6/1-7/1) when dry; amorphous; sticky; pH 7.7; abrupt, smooth boundary.

Horizon	Depth (cm)	Description
II(F-H)b	40 - 58	Reddish-brown, partially and fully decayed organic material.
IIC	58 - 68	Light reddish brown (5 YR 6/3) clay, light gray (10 YR 7/2) when dry; amorphous; sticky; pH 7.8; abrupt, smooth boundary.
II(F-H)b	68 - 81	Dark brown, partially and fully decayed organic material.
IIIHb	81 - 90	Humus, altered organic material.
IIIC	90 +	

Sub-group: Carbonated Rego Gleysol

Profile No. M18

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	6-0	7.8	nd	31.2	nd	1.2	nd	nd	.7	2.0	74.8	22.5	83.0	nd
AC	0-12	7.9	nd	12.0	nd	.2	nd	nd	.3	.8	78.5	20.4	9.4	nd
Cca	12-26	7.7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
C	26-40	7.7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
II(F-H)b	40-58	7.4	nd	nd	33.2	1.9	nd	nd	1.1	2.0	74.6	22.3	113.0	nd
IIC	58-68	7.8	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
III(F-H)b	68-81	7.0	nd	nd	37.4	1.8	nd	nd	nd	nd	nd	nd	nd	nd
IIIHb	81-90	7.4	nd	25.4	nd	1.4	nd	nd	1.3	2.3	79.1	17.3	110.2	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	6-0	nd	nd	nd	nd	nd	nd	nd	nd	331.1	156.5	65.2	91.3	8.3	nd	nd	nd
AC	0-12	0	16	11	73	16	nd	nd	nd	84.2	57.6	12.0	45.6	1.3	nd	nd	nd
Cca	12-26	0	11	30	60	10	nd	nd	nd	99.5	69.8	13.8	56.0	1.8	nd	nd	nd
C	26-40	0	10	56	34	16	nd	nd	nd	128.7	84.0	21.3	62.7	3.0	.24	.04	.28
II(F-H)b	40-58	nd	nd	nd	nd	nd	nd	nd	nd	315.2	169.2	92.3	77.2	11.8	nd	nd	nd
IIC	58-68	0	17	38	45	14	nd	nd	nd	81.2	63.7	14.5	49.2	2.0	nd	nd	nd
III(F-H)b	68-81	nd	nd	nd	nd	nd	nd	nd	nd	389.2	190.0	119.7	70.3	13.3	nd	nd	nd
IIIHb	81-90	nd	nd	nd	nd	nd	nd	nd	nd	nd	136.1	61.4	74.7	9.7	nd	nd	nd

Sub-group: .... Brunisolic Gray Luvisol.

Profile number: .... M 19.

Location: .... Near Forestry Plot #40.

Vegetation: Tree canopy: .... Pinus sp., Picea sp..

Understory: .... Salix sp..

Ground: .... Linnaea sp., Calamagrostis sp..

Parent material: .... Aeolian Colluvium/Till I, compacted phase.

Topography: .... Strongly sloping; aspect N.E..

Elevation: .... 5595 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	2 - 0	Organic material in various stages of decomposition.
(Aeh)	0 - 3	Grayish brown to light brownish gray (10 YR 5/2-6/2) silt loam, light gray to very pale brown (10 YR 7/2-8/3) when dry; weak, coarse platy breaking to moderate, medium granular; very friable; pH 6.8; abrupt, smooth boundary.
(Bf)	3 - 6	Yellowish red (5 YR 4/8) silt loam, brownish yellow to yellow (10 YR 6/8-7/6) when dry; strong, coarse platy breaking to strong, coarse granular; friable; pH 6.6; slightly gravelly to slightly channery; clear, smooth to wavy boundary.

Horizon	Depth (cm)	Description
IIAe	6 - 10	Brown to yellowish brown (10 YR 5/3-5/4) silt loam, light gray to very pale brown (10 YR 7/2-9/3) when dry; weak, medium platy; friable; pH 6.8; slightly channery; gradual, smooth boundary.
IIBt1	10 - 15	Dark brown to brown (10 YR 4/3-5/3) clay loam, light yellowish brown to very pale brown (10 YR 6/4-2/3) when dry; strong, medium subangular blocky; firm; pH 6.6; slightly gravelly to slightly cobbly; gradual, smooth boundary.
IIBt2	15 - 28	Dark yellowish brown (10 YR 4/4) clay loam, yellowish brown (10 YR 5/4) when dry; strong, medium subangular blocky; firm; pH 6.6; moderately gravelly to moderately cobbly; clear, smooth boundary.
IIC	28 - 62 +	Very dark gray (10 YR 3/5) clay loam, dark gray (10 YR 4/1) when dry; amorphous; firm; pH 7.7; strong effervescence; moderately gravelly to moderately channery.

Sub-group: Brunisolic Gray Luvisol Profile No. M19

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	2-0	6.6	nd	nd	15.4	.56	28	17.5	1.9	2.6	69.5	8.5	39.2	nd
(Aeh)	0-3	6.8	nd	nd	2.0	.10	19	7.9	1.9	3.7	81.9	4.6	18.5	nd
(Bf)	3-6	6.6	nd	nd	2.1	.22	10	8.9	1.6	2.3	81.4	5.8	23.7	nd
IIAe	6-10	6.8	nd	nd	1.2	.06	22	1.7	.8	2.1	85.8	9.6	15.3	nd
IIBt1	10-15	6.6	nd	nd	1.7	.06	29	5.1	1.0	2.5	86.8	4.6	5.7	nd
IIBt2	15-28	6.6	nd	nd	1.0	.07	14	4.5	3.5	1.8	75.0	15.2	15.1	nd
IIC	28-62+	7.7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	2-0	nd	nd	nd	nd	nd	nd	nd	nd	142.7	60.9	25.8	35.1	4.7	nd	nd	nd
(Aeh)	0-3	5	21	59	20	7	.87	65.8	76	36.0	29.0	9.3	19.7	2.1	.35	.03	.38
(Bf)	3-6	3	15	59	26	10	.87	65.5	75	44.6	29.8	13.3	16.5	2.7	.82	.09	.91
IIAe	6-10	6	17	61	22	8	nd	nd	nd	30.9	24.0	9.4	14.6	1.8	.82	.09	.91
IIBt1	10-15	9	25	47	28	14	1.04	61.1	58	28.4	21.0	11.1	9.9	2.0	.49	.04	.53
IIBt2	15-28	25	24	45	31	15	.94	64.8	68	29.8	21.3	11.1	10.2	1.9	.60	.05	.66
IIC	28-62+	34	26	46	28	11	.82	69.6	85	19.0	13.4	6.6	6.8	.9	.62	.06	.68

Sub-group: .... Orthic Gray Luvisol.

Profile number: .... M 20.

Location: .... Near Forestry Plot #24.

Vegetation: Tree canopy: .... Picea sp., Pinus sp., Abies sp..

Understory: .... Menziesia sp..

Ground: .... Moss, Linnaea sp., Cornus sp., Vaccinium sp., Pyrola sp..

Parent material: .... Till Colluvium/Till I.

Topography: .... Strongly sloping; aspect N.E..

Elevation: .... 5830 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	20 - 0	Organic material in various stages of decomposition.
Ae	0 - 10	Light brown (7.5 YR 6/4) silt loam light gray to very pale brown (10 YR 7/2-7/3) when dry; weak, coarse platy breaking to strong, coarse granular; friable; pH 5.6; moderately to very angular gravelly; clear, wavy boundary.
Bt	10 - 22	Yellowish brown (10 YR 5/4) silt loam, pale brown to light yellowish brown (10 YR 6/3-6/4) when dry; strong, medium subangular blocky; firm; pH 5.9; very angular cobbly; clear, smooth boundary.

Horizon	Depth (cm)	Description
BC	22 - 36	Dark grayish brown (10 YR 4/2) silty clay loam, yellowish brown (10 YR 5/4) when dry; amorphous; pH 6.7; very angular cobbly; gradual, smooth boundary
IIC	36 - 65 +	Very dark gray (10 YR 3/1) silt loam, gray (10 YR 5/1) when dry; pH 7.4; amorphous; friable; very stony.

Sub-group: Orthic Gray Luvisol

Profile No. M20.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	20-0	4.8	nd	nd	39.1	.9	41	50.3	.4	.3	42.1	6.9	82.4	nd
Ae	0-10	5.6	nd	nd	1.87	.1	23	25.0	1.2	2.4	60.4	11.0	14.4	nd
Bt	10-22	5.9	nd	nd	1.2	.1	15	11.6	.6	2.7	67.3	17.8	15.9	nd
BC	22-36	6.7	nd	nd	1.4	nd	nd	3.2	1.9	1.9	61.3	31.8	17.3	nd
C	36-65+	7.4	nd	nd	nd	nd	nd	nd	.8	9.9	80.2	9.1	12.0	nd

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	20-0	0	nd	nd	nd	nd	nd	nd	nd	280.4	122.1	80.7	41.4	8.7	nd	nd	nd
Ae	0-10	4	18	65	17	5	nd	nd	nd	25.2	25.7	8.1	17.6	1.6	nd	nd	nd
Bt	10-22	10	14	54	32	15	nd	nd	nd	26.9	23.5	11.7	11.8	2.0	nd	nd	nd
BC	22-36	32	18	53	29	12	nd	nd	nd	28.0	22.0	11.8	10.2	2.1	nd	nd	nd
C	36-65+	29	22	51	27	9	nd	nd	nd	35.7	20.9	10.9	10.0	1.5	nd	nd	nd

Sub-group: .... Degraded Dystric Brunisol, (Class B)

Profile number: .... M 21.

Location: .... Near Forestry Plot #247.

Vegetation: Tree Canopy: .... *Picea* sp..

Understory: .... *Menziesia* sp..

Ground: .... Moss.

Parent material: .... Colluvium/Colluvium.

Topography: .... Extremely sloping; aspect ENE.

Elevation: .... 6600 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L	8 - 7	Matted, undecayed organic material.
F - H	7 - 0	Spongy, partially and fully decayed organic material.
Aej	0 - 8	Grayish brown (10 YR 5/2) loam, light brownish gray to light gray (10 YR 6/2-7/2) when dry; strong, medium platy; very friable; pH 4.3; gradual, wavy boundary.
Bfj	8 - 33	Reddish brown (5 YR 4/3) loam, grayish brown to light brownish gray (10 YR 5/2-6/2) when dry; weak, coarse platy breaking to strong, medium granular; very friable; pH 5.2; slightly channery; clear, smooth boundary.

Horizon	Depth (cm)	Description
BC	33 - 57	Dark reddish brown to dark reddish gray (5 YR 3/2-4/2) loam to silt loam, light brownish gray (10 YR 6/2) when dry; strong, medium granular; very friable; pH 5.0; slightly channery; abrupt, smooth boundary.
IIACb	57 - 63	Very dark gray (10 YR 3/5) sandy loam, gray to grayish brown (10 YR 5/1-5/2) when dry; weak, medium granular; very friable; pH 6.0; moderately gravelly; abrupt, smooth boundary.
IIC	63 - 90 +	Dark gray (10 YR 4/1) loam, light brownish gray (10 YR 6/2) when dry; amorphous; very friable; pH 6.2; moderately gravelly.

Sub-group: Degraded Dystric Brunisol (Class B) Profile No. M21.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis						pH-depend. C.E.C.
								exch. acid.	Na	K	Ca	Mg	TEC	
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L	8-7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
F-H	7-0	4.4	nd	nd	32.4	.76	nd	nd	nd	nd	nd	nd	59.4	nd
Aej	0-8	4.3	nd	nd	5.1	.18	28	66.4	.7	2.6	25.0	5.3	18.8	96.9
Bfj	8-33	5.2	nd	nd	2.5	.12	16	56.3	.8	1.6	33.5	7.8	13.7	96.9
BC	33-57	5.0	nd	nd	2.3	.10	22	nd	nd	nd	nd	nd	15.0	97.4
IIACb	57-63	6.0	nd	nd	5.7	.10	56	23.8	.8	.8	65.5	5.1	14.4	99.9
IIC	63-90+	6.2	nd	nd	3.5	nd	nd	11.2	.0	.9	80.4	7.5	12.2	nd

Horizon	Depth	Mechanical Analysis					Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis					Free R_2O_3 (Oxalate)		
		G	S	Si	C	FC				Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L	8-7	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
F-H	7-0	nd	nd	nd	nd	nd	nd	nd	nd	199.5	99.5	65.2	34.3	5.3	nd	nd	nd
Aej	0-8	2	32	46	22	9	nd	nd	nd	40.1	21.8	10.0	11.8	1.9	.05	.04	.09
Bfj	8-33	8	35	48	17	7	nd	nd	nd	23.3	17.6	7.6	10.0	1.5	.06	.05	.11
BC	33-57	10	35	50	15	7	nd	nd	nd	18.2	16.3	6.7	9.6	1.5	.04	.04	.08
IIACb	57-63	28	54	37	9	7	nd	nd	nd	14.4	15.3	5.9	9.4	1.1	nd	nd	nd
IIC	63-90+	26	42	48	10	5	nd	nd	nd	18.5	20.0	5.6	14.4	1.1	nd	nd	nd

Sub-group: .... Mini Ferro-Humic Podzol.

Profile number: .... M 22.

Location: .... Near Forestry Plot #329.

Vegetation: Tree Canopy: .... *Abies* sp., *Picea* sp..

Understory: ....

Ground: .... *Vaccinium scoparium*, moss.

Parent material: .... Colluvium/Aeolian/Till 1.

Topography: .... Very steeply sloping, aspect NE.

Elevation: .... 7020 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	6 - 0	Organic material in various stages of decomposition.
Ae	0 - 10	Grayish brown (10 YR 5/2) silt loam, gray to light gray (10 YR 6/1) when dry; strong, medium platy; very friable; pH 4.3; abrupt, wavy boundary.
IIBf1	10 - 22	Yellowish red (5 YR 5/8) silt loam, light reddish brown to reddish yellow (10 YR 6/4-6/6 when dry; weak, coarse platy breaking to strong, medium granular; very friable; pH 5.5; abrupt, wavy boundary.
IIIBf2	22 - 48	Reddish gray to reddish brown (5 YR 5/2-5/3) silt loam, very pale brown (10 YR 7/4) when dry; strong, medium granular; very friable; pH 5.4; very angular cobbly;

Horizon	Depth (cm)	Description
IIIBf2	22 - 48	gradual, smooth boundary.
IIIBC	48 - 68	Brown (7.5 YR 5/2) loam, pale brown (10 YR 6/3) when dry; weak, medium granular; very friable; pH 5.9; very angular cobbly; clear, smooth boundary.
IIIC	68 - 75 +	Dark gray (10 YR 4/1) silt loam, dark grayish brown to brown (10 YR 4/2-4/3) when dry; single grained; very friable; pH 6.3; very angular cobbly.

Sub-group: Mini Ferro-Humic Podzol

Profile No. M22.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	6-0	4.8	nd	nd	30.5	1.06	nd	47.0	.5	5.5	41.6	5.4	67.0	nd
Ae	0-10	4.3	nd	nd	2.7	.2	15.0	82.8	.8	1.1	12.3	3.0	12.6	nd
IIBf1	10-22	5.5	nd	nd	2.7	.2	17.8	88.0	7.4	.9	2.8	.9	14.0	nd
IIBf2	22-48	5.4	nd	nd	1.3	.1	21.9	53.8	1.3	2.6	34.6	7.7	26.0	nd
IIIBC	48-68	5.9	nd	nd	1.2	.1	nd	19.4	1.0	2.0	70.4	7.2	27.7	nd
IIIC	68-75+	6.3	nd	nd	nd	nd	nd	16.6	.9	1.8	73.4	7.3	13.2	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	6-0	nd	nd	nd	nd	nd	nd	nd	nd	223.3	120.7	89.9	30.8	6.9	nd	nd	nd
Ae	0-10	2	20	54	26	11	.87	63.7	73	43.2	32.7	12.5	20.2	3.4	.05	.08	.13
IIBf1	10-22	4	33	59	8	2	.50	77.8	156	75.7	49.3	15.2	34.1	6.0	.34	.81	1.15
IIBf2	22-48	35	28	56	16	7	1.30	51.1	39	17.2	19.1	6.7	12.4	1.3	.08	.08	.16
IIIBC	48-68	60	41	45	14	7	nd	nd	nd	18.5	16.9	8.0	8.9	1.1	.07	.06	.13
IIIC	68-75+	61	24	47	19	8	nd	nd	nd	12.9	13.7	7.7	6.0	1.1	.06	.06	.12

Sub-group: .... Rego Humic Gleysol.

Profile number: .... M 23.

Location: .... Near Forestry Plot #333.

Vegetation: Tree canopy: ....

Understory: ....

Ground: .... *Carex* sp., *Salix* sp., *Dryas* sp., *Castilleja* sp..

Parent material: .... Colluvium/Rock.

Topography: .... Very steeply sloping; aspect N.

Elevation: .... 7010 ft. M.S.L..

Drainage: .... Very poor.

Horizon	Depth (cm)	Description
L - H	5 - 0	Organic material in various stages of decomposition.
Aeh	0 - 18	Very dark grayish brown (10 YR 3/2) loam, dark grayish brown (10 YR 4/2) when dry; moderate, medium granular; very friable; pH 6.4; exceedingly shaly; clear, smooth boundary.
C	18 - 40	Very dark gray (10 YR 3/1) loam, very dark gray (10 YR 3/1) when dry; single grained; very friable; pH 6.7; exceedingly shaly.
R	40 +	

Sub-group: Rego Humic Gleysol

Profile No. M23

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	5-0	5.8	nd	nd	24.1	.5	nd	20.9	1.7	3.5	72.2	1.7	59.4	nd
Aeh	0-18	6.4	nd	nd	7.0	.2	34.8	17.8	1.0	1.0	73.6	6.6	21.8	nd
C	18-40	6.7	nd	nd	nd	nd	nd	nd	.4	.9	96.6	2.1	32.0	nd
Rock	40+													

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	5-0	nd	nd	nd	nd	nd	nd	nd	nd	180.1	88.8	65.2	23.6	8.2	nd	nd	nd
Aeh	0-18	45	31	47	22	11	nd	nd	nd	33.3	22.3	11.3	11.0	2.8	nd	nd	nd
C	18-40	40	31	49	20	9	nd	nd	nd	23.4	20.1	11.6	8.5	2.5	nd	nd	nd

Sub-group: .... Orthic Humic Gleysol.

Profile number: .... M 24.

Location: .... Cirque near snowstation.

Vegetation: Tree canopy: .... *Picea* sp..

Understory: .... *Salix* sp..

Ground: .... *Juncus* sp., *Carex* sp., *Senecio* sp., *Pedicularis* sp..

Parent material: .... Alluvium/Colluvium/Lacustrine/Till II.

Topography: .... Moderately to strongly sloping; aspect ESE.

Elevation: .... 7230 ft. M.S.L..

Drainage: .... Poor.

Horizon	Depth (cm)	Description
L	20 - 16	Matted, undecayed organic material.
F	16 - 13	Fermented organic material.
H1	13 - 5	Humus; altered organic material.
H2	5 - 0	Humus; altered organic material.
Ah	0 - 13	Black to dark brown (10 YR 2/1-3/3) clay; dark gray to very dark gray and very dark grayish brown (10 YR 4/1 and 3/1-3/2) when dry; strong, medium granular; friable; pH 6.3; moderately channery; abrupt, smooth boundary.
IIB	13 - 35	Dark gray to very dark grayish brown (10 YR 4/1-3/2) loam, very dark grayish brown to dark brown (10 YR 3/2-3/3) when dry; strong, fine granular to single

Horizon	Depth (cm)	Description
IIB	13 - 35	grained; very friable; pH 6.5; very channery; abrupt, smooth boundary.
IIIAhb	35 - 38	Very dark gray (10 YR 3/1) clay, dark gray to very dark grayish brown (10 YR 4/5-3/2) when dry; strong, fine blocky; firm; pH 6.4; abrupt, wavy boundary.
IVC	38 - 50 +	Dark gray to very dark grayish brown (10 YR 4/1-3/2) loam, dark gray (10 YR 4/1) when dry; amorphous; very friable; pH 6.7; very channery.

Sub-group: Orthic Humic Gleysol Profile No. M24.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L	20-16	6.0	nd	nd	37.5	1.00	nd	15.2	.4	7.7	66.3	10.4	88.0	nd
F	16-13	6.8	nd	nd	40.7	1.65	nd	6.2	.5	4.4	83.1	5.8	118.5	nd
H1	13-5	6.4	nd	nd	38.4	2.0	nd	4.3	.2	.9	89.3	5.3	118.6	nd
H2	5-0	6.2	nd	nd	21.7	2.0	nd	13.1	.2	.2	81.5	5.0	106.4	nd
Ah	0-13	6.3	nd	nd	10.3	.6	18.4	12.0	.2	.5	79.1	8.2	54.4	nd
IIB	13-35	6.5	nd	nd	1.9	.1	27.2	7.3	.9	.9	74.4	16.5	11.1	nd
IIIAhb	35-38	6.4	nd	nd	4.6	.4	nd	5.3	2.3	.9	81.5	10.0	33.6	nd
IVC	38-50+	6.7	nd	nd	nd	nd	nd	8.2	.8	1.6	79.5	9.9	13.3	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L	20-16	nd	nd	nd	nd	nd	nd	nd	nd	710.0	220.3	141.2	79.1	9.0	nd	nd	nd
F	16-13	nd	nd	nd	nd	nd	nd	nd	nd	433.4	229.0	141.2	87.8	11.8	nd	nd	nd
H1	13-5	nd	nd	nd	nd	nd	nd	nd	nd	305.4	192.0	125.6	66.4	14.8	nd	nd	nd
H2	5-0	nd	nd	nd	nd	nd	.58	nd	nd	203.4	139.3	93.0	46.3	13.1	.15	.23	.38
Ah	0-13	6	17	34	49	24	.95	56.6	59	55.7	50.3	26.0	24.3	7.3	.18	.40	.58
IIB	13-35	46	33	45	22	12	1.43	46.6	33	16.8	9.6	6.4	3.2	1.0	.05	.03	.08
IIIAhb	35-38	9	13	39	48	27	nd	nd	nd	40.4	29.3	19.3	10.0	3.3	nd	nd	nd
IVC	38-50+	55	47	36	17	8	nd	nd	nd	19.5	12.5	7.5	5.0	1.0	nd	nd	nd

Sub-group: .... Alpine Dystric Brunisol, (Class A)

Profile number: .... M 25.

Location: .... 5 chains north of Cirque Pit.

Vegetation: Tree Canopy: .... Larix sp..

Understory: .... Picea sp..

Ground: .... Vaccinium scoparium, Glycorrhiza sp., Antennaria sp., Aquilegia sp..

Parent material: .... Colluvium/Till II.

Topography: .... Steeply sloping; aspect SSE.

Elevation: .... 7260 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	3 - 0	Organic material in various stages of decomposition.
Aeh	0 - 8	Very dark grayish brown (10 YR 3/2) loam, grayish brown (10 YR 5/2) when dry; strong, fine granular; very friable; pH 4.7; abrupt, wavy boundary.
Bfj	8 - 18	Dark reddish brown (5 YR 3/3) loam, yellowish brown to light yellowish brown (10 YR 5/4-6/4) when dry; strong, medium granular; very friable; pH 4.9; abrupt, wavy boundary.
IIBC	18 - 42	Brown (10 YR 5/3) loam, light yellowish brown (10 YR 6/4) when dry; single grained; very friable; pH 5.0; very channery;

Horizon	Depth (cm)	Description
IIBC	18 - 42	clear, smooth boundary.
IIC	42 - 70 +	Very dark grayish brown (10 YR 3/2) loam, light brownish gray (10 YR 6/2) when dry; single grained; very friable; pH 5.5; very channery.

Sub-group: Alpine Dystric Brunisol (Class A) Profile No. M25.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	3-0	5.4	nd	nd	21.2	.94	nd	27.7	.2	3.5	64.9	3.7	44.7	nd
Aeh	0-8	4.7	nd	nd	4.9	.25	20	56.8	.5	1.6	36.8	4.3	25.9	89.4
Bfj	8-18	4.9	nd	nd	3.8	.16	24	63.5	.6	.6	29.5	5.8	24.3	88.1
IIBC	18-42	5.0	nd	nd	2.2	.08	nd	47.2	.0	.9	41.7	10.2	15.6	88.6
IIC	42-70+	5.5	nd	nd	1.8	nd	nd	28.6	1.0	1.0	57.1	12.3	12.8	99.3

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	3-0	nd	nd	nd	nd	nd	nd	nd	nd	177.7	57.5	47.1	10.4	5.4	nd	nd	nd
Aeh	0-8	15	26	49	25	9	.99	59.6	60	27.3	19.5	11.7	7.8	2.1	.08	.08	.16
Bfj	8-18	8	29	49	22	7	1.33	47.2	35	29.5	22.2	10.1	12.1	2.6	.24	.14	.38
IIBC	18-42	44	37	46	17	5	1.56	40.7	26	16.4	13.5	6.5	7.0	1.3	.10	.08	.18
IIC	42-70+	34	40	46	14	5	1.38	47.1	35	16.8	12.5	6.0	6.5	1.1	.07	.07	.14

Sub-group: .... Orthic Regosol (formerly Deorcic Regosol).

Profile number: .... M 26.

Location: .... Grassy slope north of Cirque.

Vegetation: Tree canopy: ....

Understory: ....

Ground: .... *Elymus* sp., *Carex* sp., *Juncus* sp., forbs.

Parent material: .... Colluvium/Colluvium.

Topography: .... Extremely sloping; aspect SSE.

Elevation: .... 7340 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - F	5 - 0	Root mat, containing humus in various stages of decomposition and some inorganic material.
Ahj	0 - 6	Very dark grayish brown (10 YR 3/2) loam, very dark grayish brown (10 YR 3/2) when dry; strong, medium granular; very friable; pH 4.9; very shaly, clear, wavy boundary.
Bmj	6 - 22	Dark brown (10 YR 3/3) silt loam, brown to yellowish brown (10 YR 4/3-5/4) when dry; strong, coarse granular to strong, fine subangular blocky; very friable; pH 5.4; very shaly; grandual, wavy boundary.
BC	22 - 42	Very dark brown (10 YR 2/2) loam, dark brown (10 YR 3/3) when dry; strong, fine

Horizon	Depth (cm)	Description
BC	22 - 42	granular; very friable; pH 5.8; very shaly; abrupt, smooth boundary.
IIAhb	42 - 65 +	Black (10 YR 2/1) loam, very dark gray (10 YR 3/1) when dry; strong, medium granular; very friable; pH 6.0; very to exceedingly shaly.

Sub-group: Orthic Regosol (formerly Deorcic Regosol) Profile No. M26.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-F	5-0	5.7	nd	nd	16.5	.9	nd	20.5	.8	7.8	64.5	6.3	46.8	nd
Ahj	0-6	4.9	nd	nd	7.3	.4	20.7	43.5	.5	1.6	45.7	8.7	18.3	nd
Bmj	6-22	5.4	nd	nd	3.7	.2	19.7	37.5	.8	1.7	53.3	6.7	12.8	nd
BC	22-42	5.8	nd	nd	4.7	.2	nd	29.3	.8	1.6	56.9	11.4	14.4	nd
IIAhb	42-65+	6.0	nd	nd	3.7	.1	29.1	23.5	1.0	1.0	66.7	7.8	10.2	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-F	5-0	nd	nd	nd	nd	nd	nd	nd	nd	99.9	55.0	45.5	9.5	3.9	nd	nd	nd
Ahj	0-6	12	30	49	21	7	.95	61.7	65	37.0	19.3	13.4	5.9	2.0	.08	.08	.16
Bmj	6-22	28	33	51	16	5	.99	61.5	62	22.6	15.4	8.5	6.9	1.5	.09	.07	.16
BC	22-42	33	35	46	19	8	nd	nd	nd	24.8	15.4	8.8	6.6	1.6	.09	.10	.19
IIAhb	42-65+	47	34	44	22	7	nd	nd	nd	19.6	14.7	8.5	6.2	1.2	nd	nd	nd

Sub-group: .... Alpine Dystric Brunisol, (Class B)

Profile number: .... M 27.

Location: .... North of Forestry Plot #482.

Vegetation: Tree canopy: ....

Understory: ....

Ground: .... *Kobresia* sp., *Carex* sp., *Agoseros* sp..

Parent material: .... Colluvium/Rock.

Topography: .... Extremely sloping; aspect SSE.

Elevation: .... 7410 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - F	5 - 0	Root mat.
Ah	0 - 12	Very dark brown to very dark gray (10 YR 2/2-3/1) clay loam, very dark gray to very dark grayish brown (10 YR 3/1-3/2) when dry; strong, medium granular; friable; pH 5.2; very shaly; clear, smooth boundary.
Bm	12 - 25	Dark yellowish brown (10 YR 3/4) loam, brown to dark brown (10 YR 4/3) when dry; weak, medium subangular blocky; very friable; pH 5.5; very shaly; clear, wavy boundary.
C	25 - 40	Very dark brown (10 YR 2/2) loam, dark grayish brown (10 YR 4/2) when dry; single grained, very friable; pH 5.8; exceedingly shaly.

Sub-group: Alpine Dystric Brunisol (Class B) Profile No. M27.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-F	5-0	5.9	nd	nd	22.2	1.04	nd	19.9	1.5	2.3	70.0	6.3	59.4	nd
Ah	0-12	5.2	nd	nd	9.6	.53	18.2	41.4	.5	1.0	50.4	6.7	21.7	nd
Bm	12-25	5.5	nd	nd	3.8	.12	31.7	25.5	.0	.9	67.0	6.6	15.4	nd
C	25-40	5.8	nd	nd	nd	nd	nd	23.5	.7	2.2	69.2	4.4	16.6	nd
Rock	40+	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-F	5-0	nd	nd	nd	nd	nd	nd	nd	nd	113.0	61.6	52.5	9.1	6.7	nd	nd	nd
Ah	0-12	6	28	45	27	8	.92	62.3	68	40.2	18.8	12.5	6.3	3.2	.09	.09	.18
Bm	12-25	44	35	48	17	5	1.14	55.8	49	21.2	14.7	9.1	5.6	1.1	.06	.06	.12
C	25-40	39	41	44	15	5	nd	nd	nd	23.8	19.5	8.8	10.7	1.5	.10	.09	.19
Rock	40+	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Sub-group: .... Cumulic Regosol.

Profile number: .... M 28.

Location: .... Grassy slope S. E. of anemometer.

Vegetation: Tree canopy: ....

Understory: ....

Ground: .... _Elymus_ sp., _Kobresia_ sp., _Carex_ sp., forbs.

Parent material: .... Colluvium.

Topography: .... Extremely sloping; aspect SE.

Elevation: .... 7360 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - F	2 - 0	Root mat, containing humus in various stages of decomposition and also some inorganic material.
Ah1	0 - 25	Black (10 YR 2/1) loam to silt loam, black (10 YR 2/1) when dry; strong, fine granular; very friable; pH 6.7; slightly shaly; abrupt, smooth boundary.
Ah2	25 - 60	Very dark brown (10 YR 2/2) loam, very dark gray to very dark brown (10 YR 3/1-2/2) when dry; strong, medium granular; very friable; pH 6.8; very shaly; clear, smooth boundary.
Ah3	60 - 80 +	Black (10 YR 2/1) sandy clay loam, very dark gray (10 YR 3/1) when dry; strong

Horizon	Depth (cm)	Description
Ah3	60 - 80 +	medium granular; very friable; pH 7.0; very shaly.

Sub-group: Cumulic Regosol

Profile No. M28.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-F	2-0	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ah1	0-25	6.7	nd	nd	20.0	.5	41.4	7.2	.3	2.8	82.9	6.8	32.6	nd
Ah2	25-60	6.8	nd	nd	7.4	.2	42.9	6.4	.0	1.3	78.8	13.5	18.2	nd
Ah3	60-80+	7.0	nd	nd	9.1	.1	67.6	5.5	.0	.5	85.3	8.7	22.9	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe ÷ Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-F	2-0	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ah1	0-25	3	27	50	23	12	nd	nd	nd	60.4	25.0	19.4	5.6	3.7	nd	nd	nd
Ah2	25-60	11	38	45	17	6	nd	nd	nd	22.4	14.2	7.8	6.4	1.4	nd	nd	nd
Ah3	60-80+	15	53	26	21	11	nd	nd	nd	26.4	13.9	7.5	6.4	1.3	nd	nd	nd

Sub-group: .... Degraded Dystric Brunisol, (Class B)

Profile number: .... M 29.

Location: .... Near Forestry Plot #398.

Vegetation: Tree canopy: .... Picea sp., Abies sp., Larix sp..

Understory: ....

Ground: .... Moss, Vaccinium scoparium.

Parent material: .... Colluvium/Till II.

Topography: .... Very steeply sloping; aspect SE.

Elevation: .... 7200 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	6 - 0	Organic material in various stages of decomposition.
Aej	0 - 10	Brown to grayish brown (10 YR 4/3-5/2) loam, pale brown (10 YR 6/3) when dry; weak, coarse platy; very friable; pH 5.3; moderately gravelly; clear, smooth boundary.
AB	10 - 18	Dark brown to brown (7.5 YR 4/4) loam, very pale brown (10 YR 7/4) when dry; weak, coarse platy breaking to strong, medium granular; very friable; pH 5.0; moderately gravelly; clear, wavy boundary.
Bfj1	18 - 30	Dark brown to brown (7.5 YR 4/4) loam, pale brown to light yellowish brown (10 YR 6/3-6/4) when dry; weak, medium

Horizon	Depth (cm)	Description
Bfj1	18 - 30	granular; friable; pH 5.0; moderately gravelly; abrupt, wavy boundary.
IIBfj2	30 - 42	Brown to yellowish brown (10 YR 5/3-5/4) loam, very pale brown (10 YR 2/3) when dry; weak, fine granular; very friable; pH 5.2; excessively gravelly; abrupt, smooth boundary.
IIBC	42 - 55	Yellowish brown (10 YR 5/4) loam, light gray (10 YR 7/2) when dry; weak, medium granular; very friable; pH 5.1; very to exceedingly gravelly; abrupt, smooth boundary.
IIC	55 +	Yellowish brown to very dark grayish brown (10 YR 5/4-3/2) loam, light brownish gray to pale brown (10 YR 6/2-6/3) when dry; amorphous; very friable; pH 5.3; exceedingly gravelly.

Sub-group: Degraded Dystric Brunisol (Class B) Profile No. M29.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	6-0	5.8	nd	nd	42.5	1.2	nd	15.1	.1	2.5	82.3	.0	92.0	nd
Aej	0-10	5.3	nd	nd	2.9	.1	44.6	34.9	.0	3.5	57.0	4.7	12.3	nd
AB	10-18	5.0	nd	nd	1.7	.1	27.4	54.2	1.2	3.6	33.7	7.3	14.4	nd
Bfj1	18-30	5.0	nd	nd	1.7	.1	25.3	70.8	2.8	4.2	18.0	4.2	13.5	nd
IIBfj2	30-42	5.2	nd	nd	1.2	.1	27.1	63.6	.0	3.6	14.6	18.2	7.1	nd
IIBC	42-55	5.1	nd	nd	.5	.0	15.1	74.6	.0	3.6	21.8	.0	6.9	nd
IIC	55+	5.3	nd	nd	nd	nd	nd	63.4	.0	2.4	34.2	.0	5.4	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	6-0	nd	nd	nd	nd	nd	nd	nd	nd	238.2	97.8	94.9	2.9	9.4	nd	nd	nd
Aej	0-10	46	48	40	12	5	nd	nd	nd	22.5	14.7	6.2	8.5	.6	.07	.04	.11
AB	10-18	41	46	38	16	6	nd	nd	nd	23.3	18.8	8.2	10.6	1.0	.10	.07	.17
Bfj1	18-30	51	50	35	15	5	nd	nd	nd	21.2	18.3	6.8	11.5	1.1	.13	.07	.20
IIBfj2	30-42	68	45	42	13	4	nd	nd	nd	16.1	8.7	4.5	4.2	.7	.07	.06	.13
IIBC	42-55	46	40	45	15	4	nd	nd	nd	13.5	11.0	4.0	7.0	.8	.05	.03	.08
IIC	55+	54	34	48	18	8	nd	nd	nd	13.7	8.3	3.2	5.1	.6	.08	.06	.14

Sub-group: .... Degraded Dystric Brunisol, (Class B)

Profile number: .... M 30.

Location: .... Near Forestry Plot #430.

Vegetation: Tree canopy: .... Picea sp., Abies sp., Larix sp..

Understory: .... Menziesia sp..

Ground: .... Lycopodium sp., Moss. Vaccinium scoparium.

Parent material: .... Aeolian colluvium/Till I.

Topography: .... Very steeply sloping; aspect ENE.

Elevation: .... 6590 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	5 - 0	Organic material in various stages of decomposition.
Aej	0 - 7	Grayish brown to light brownish gray (10 YR 5/2-6/2) silt loam, light brownish gray to light gray (10 YR 6/2-7/1) when dry; strong, medium platy; very friable; pH 4.3; slightly gravelly; abrupt, smooth boundary.
Bf1	7 - 27	Reddish brown to yellowish red (5 YR 4/4-4/6) silt loam, light yellowish brown to brownish yellow (10 YR 6/4-6/6) when dry; weak, coarse platy breaking to strong, medium granular; very friable; pH 5.4; moderately gravelly; abrupt, broken boundary.

Horizon	Depth (cm)	Description
IIBf2	27 - 48	Brown to yellowish brown (10 YR 4/3-5/4) loam, light yellowish brown (10 YR 6/4) when dry; strong, medium granular; friable; pH 5.1; exceedingly gravelly; abrupt, smooth boundary.
IIC	48 - 72 +	Very dark gray (10 YR 3/1) loam, grayish brown (10 YR 5/2) when dry; amorphous to single grained; friable; pH 7.4; exceedingly gravelly.

Sub-group: Degraded Dystric Brunisol (Class A)   Profile No. M30

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	5-0	4.4	nd	nd	41.2	1.1	nd	53.6	.1	6.5	32.3	7.5	98.8	nd
Aej	0-7	4.3	nd	nd	2.5	.1	19.0	82.6	.5	1.1	11.1	4.7	25.1	nd
Bf1	7-27	5.4	nd	nd	3.2	.1	34.7	78.4	1.0	1.0	15.7	3.9	21.1	nd
IIBf2	27-48	5.1	nd	nd	1.5	.1	23.6	25.4	nd	.5	72.0	2.1	13.7	nd
IIC	48-72+	7.4	5.0	nd	nd	nd	nd	nd	nd	.8	94.4	4.8	12.6	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	5-0	nd	nd	nd	nd	nd	nd	nd	nd	488.5	145.6	116.9	28.7	8.0	nd	nd	nd
Aej	0-7	10	24	55	21	9	.77	68.0	89	51.3	32.2	13.3	18.7	2.1	.04	.07	.11
Bf1	7-27	39	29	52	19	5	.72	71.2	99	36.9	24.4	9.6	14.8	3.1	.32	.56	.88
IIBf2	27-48	53	42	38	20	10	1.01	61.6	61	23.9	14.8	8.1	6.7	1.6	.13	.13	.26
IIC	48-72+	48	47	37	16	6	.89	66.9	75	26.9	14.3	6.8	7.5	1.0	.10	.07	.17

Sub-group: .... Terric Fibrisol.

Profile number: .... M 31.

Location: .... Near Forestry Plot #103.

Vegetation: Tree canopy: .... *Picea* sp., *Pinus* sp..

Understory: .... *Menziesia* sp., *Potentilla fruticosa*, *Salix* sp..

Ground: .... *Carex* sp., *Arnica* sp..

Parent material: .... Aeolian/Till 1/Rock.

Topography: .... Strongly sloping; aspect ENE.

Elevation: .... 6150 ft. M.S.L.

Drainage: .... Very poor.

Horizon	Depth (cm)	Description
H1	40 - 20	Humus; altered organic material.
H2	20 - 0	Humus; altered organic material.
Ah	0 - 6	Black to dark brown (10 YR 2/1-2/3) silt loam, grayish brown (10 YR 5/2) when dry; strong, fine granular; very friable; pH 6.8; abrupt, wavy boundary.
C	6 - 16	Yellowish brown (10 YR 5/4) silt loam, very dark gray (10 YR 3/1) when dry; strong, medium granular; firm; pH 6.5; abrupt, wavy boundary.
IIAhb	16 - 19	Black (10 YR 2/1) silty clay loam, very dark gray (10 YR 3/1) when dry; strong, medium granular; firm; pH 6.5; abrupt, wavy boundary.

Horizon	Depth (cm)	Description
IIC	19 - 30	Dark gray (5 YR 4/1) loam, gray (10 YR 5/1) when dry; amorphous; friable; pH 6.9; moderately to very angular gravelly.
R	30 +	Rock.

Sub-group: Terric Fibrisol | Profile No. M31

Horizon	Depth	pH	$CaCO_3$ equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
F1	40-20	6.6	nd	nd	27.7	1.3	nd	4.5	.1	.3	95.1	.0	136.8	nd
F2	20-0	6.7	nd	nd	18.4	1.0	nd	7.8	.1	.1	92.0	.0	114.7	nd
Ah	0-6	6.8	nd	nd	8.9	.7	12.3	11.8	.3	.2	87.6	.0	79.5	nd
C	6-16	7.5	0.7	3.0	nd	.1	nd	9.7	.5	1.0	88.8	.0	27.1	nd
IIAhb	16-19	6.5	nd	nd	18.7	.7	nd	nd	nd	nd	nd	nd	nd	nd
IIC	19-30	6.9	nd	nd	nd	nd	nd	5.3	.5	1.1	91.0	2.1	20.1	nd
Rock	30+													

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
F1	40-20	nd	nd	nd	nd	nd	nd	nd	nd	219.5	128.0	87.5	40.5	13.8	nd	nd	nd
F2	20-0	nd	nd	nd	nd	nd	nd	nd	nd	665.0	98.1	56.7	41.4	14.3	nd	nd	nd
Ah	0-6	0	18	60	22	6	nd	nd	nd	116.8	77.8	38.7	39.1	8.2	nd	nd	nd
C	6-16	0	22	71	7	2	nd	nd	nd	nd	58.5	11.5	47.0	4.3	.30	.06	.36
IIAh	16-19	8	14	53	33	10	nd	nd	nd	nd	nd	nd	nd	10.2	nd	nd	nd
IIC	19-30	19	35	44	21	9	nd	nd	nd	31.8	26.6	9.8	16.8	1.3	nd	nd	nd

Sub-group: .... Degraded Dystric Brunisol, (Class B)

Profile number: .... M 32.

Location: .... Near Forestry Plot #245.

Vegetation: Tree canopy: .... Picea sp., Abies sp., Pinus contorta.

Understory: ....

Ground:............ Moss, Lichen.

Parent material: .... Colluvium/Till 1.

Topography: .... Steeply sloping; aspect S.

Elevation: .... 6380 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	6 - 0	Organic material in various stages of decomposition.
Aej	0 - 6	Light brownish gray to pale brown (10 YR 6/2-6/3) loam, light gray (10 YR 7/2) when dry; mottled; weak, medium platy; very friable; pH 4.8; moderately gravelly; clear wavy boundary.
Bfj1	6 - 20	Brown to reddish yellow (7.5 YR 5/4-4.6) loam, very pale brown (10 YR 7/3-7/4) when dry; strong, medium granular; friable; pH 5.3; very channery; clear, smooth boundary.
Bfj2	20 - 39	Dark brown to brown (7.5 YR 4/4-5/4) loam to clay loam, very pale brown (10 YR 7/4) when dry; weak, medium granular; friable;

Horizon	Depth (cm)	Description
Bfj2	20 - 39	very channery; clear, wavy boundary.
IIBC	39 - 55	Dark brown to brown (10 YR 4/3) loam to clay loam, pale brown (10 YR 6/3) when dry; weak, fine granular; friable; pH 6.0; very angular cobbly; abrupt, smooth boundary.
IIC	55 - 62 +	Very dark grayish brown to dark brown (10 YR 3/2-3/3) silt loam to silty clay loam, grayish brown to brown (10 YR 5/2-5/3) when dry; amorphous; friable; pH 6.3; very angular cobbly.

Sub-group: Degraded Dystric Brunisol (Class B) Profile No. M32

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	6-0	5.0	nd	nd	36.3	1.0	nd	43.3	.1	3.8	52.8	.0	89.8	nd
Aej	0-6	4.8	nd	nd	2.7	.1	31.9	46.0	.0	5.0	40.0	9.0	12.8	nd
Bfj1	6-20	5.3	nd	nd	1.4	.1	19.2	35.0	.0	3.0	58.0	4.0	13.2	nd
Bfj2	20-39	5.7	nd	nd	1.6	.1	17.6	27.6	.0	2.7	63.4	6.3	14.5	nd
IIBC	39-55	6.0	nd	nd	1.3	.1	15.1	26.3	.0	1.8	65.8	6.1	12.3	nd
IIC	55-62	6.3	nd	nd	nd	nd	nd	12.9	.0	1.4	82.3	3.4	16.6	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	6-0	nd	nd	nd	nd	nd	nd	nd	nd	226.5	104.9	95.8	9.1	7.2	nd	nd	nd
Aej	0-6	16	39	44	17	4	nd	nd	nd	26.4	14.7	6.2	8.5	1.3	.08	.02	.10
Bfj1	6-20	22	31	49	20	5	nd	nd	nd	28.0	16.9	7.3	9.6	1.4	.08	.03	.11
Bfj2	20-39	34	27	46	27	11	nd	nd	nd	26.1	16.9	8.9	8.0	1.8	.09	.04	.13
IIBC	39-55	40	28	45	27	12	nd	nd	nd	41.5	16.1	8.2	7.9	1.4	.05	.04	.09
IIC	55-62	17	20	53	27	14	nd	nd	nd	27.7	19.6	10.5	9.1	1.5	.07	.06	.13

Sub-group: .... Orthic Eutric Brunisol.

Profile number: .... M 33.

Location: .... Near Forestry Plot #68.

Vegetation: Tree canopy: .... *Picea* sp., *Abies* sp..

Understory: .... *Lonicera* sp., *Ledum* sp..

Ground: .... Moss.

Parent material: .... Aeolian colluvium/Lacustrine/Till 1.

Topography: .... Strongly sloping; aspect NE.

Elevation: .... 5940 ft. M.S.L..

Drainage: .... Imperfect to poor.

Horizon	Depth (cm)	Description
L - F	14 - 6	Non and partially decomposed organic material.
H	6 - 0	Humus; altered organic material.
Bf	0 - 8	Black and dark reddish brown (10 YR 2/1-5 YR 3/4) silt loam, brown to dark grayish grown (10 YR 5/3-4/2) when dry; weak, coarse platy breaking to strong, coarse granular; friable; pH 7.5; abrupt, smooth boundary.
IIBC	8 - 25	Very dark grayish brown to dark brown (10 YR 3/2-3/3) silty clay loam, grayish brown (10 YR 5/2) when dry; strong, coarse granular to strong, fine subangular blocky; firm; pH 7.2; slightly gravelly; clear, smooth boundary.

Horizon	Depth (cm)	Description
IIIC	25 - 60 +	Very dark grayish brown (10 YR 3/2) clay loam, gray (10 YR 5/1) when dry; amorphous; firm; pH 7.4; moderately gravelly.

Sub-group: Orthic Eutric Brunisol

Profile No. M33.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-F	14-6	7.0	1.5	nd	38.5	1.4	nd	nd	.1	1.5	98.4	.0	132.2	nd
H	6-0	7.3	1.2	nd	27.2	1.2	nd	nd	.1	.4	99.5	.0	121.4	nd
BF	0-8	7.5	.5	3.7	nd	.3	12.7	nd	.3	.9	98.2	.6	39.0	nd
IIBC	8-25	7.2	.2	nd	2.4	.2	16.0	nd	.4	1.3	94.6	3.7	24.9	nd
IIIC	25-60+	7.4	4.4	nd	nd	nd	nd	nd	.5	1.5	97.5	.5	14.6	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-F	14-6	nd	nd	nd	nd	nd	nd	nd	nd	347.0	166.7	127.0	39.7	22.1	nd	nd	nd
H	6-0	nd	nd	nd	nd	nd	nd	nd	nd	212.0	117.6	99.2	18.4	5.9	nd	nd	nd
BF	0-8	0	18	63	19	5	.98	58.3	59	74.5	50.4	21.3	29.1	1.0	.09	.50	.59
IIBC	8-25	0	6	55	39	19	1.24	51.6	42	37.9	24.6	14.2	10.4	3.4	.11	.07	.18
IIIC	25-60+	2	21	50	29	14	1.31	50.8	38	26.9	23.6	10.6	13.0	1.5	.07	.04	.11

Sub-group: .... Orthic Eutric Brunisol.

Profile number: .... M 34.

Location: .... Near Forestry Plot #251.

Vegetation: Tree canopy: .... _Picea_ sp., _Abies_ sp..

Understory: .... _Ledum_ sp..

Ground: .... Feather moss; _Linnaea borealis_.

Parent material: .... Aeolian colluvium/Colluvium.

Topography: .... Moderately sloping; aspect SSE.

Elevation: .... 6180 ft. M.S.L..

Drainage: .... Imperfect.

Horizon	Depth (cm)	Description
L - H	13 - 0	Organic material in various stages of decomposition.
Bf1	0 - 12	Dark brown to brown (7.5 YR 4/4) silt loam, yellowish brown (10 YR 5/4) when dry; weak, coarse platy breaking to strong, medium granular; friable; pH 7.7; abrupt, smooth boundary.
IIBf2	12 - 25	Dark brown to brown (7.5 YR 4/4) silt loam, grayish brown to pale brown (10 YR 5/2-6/3) when dry; strong, medium granular; friable; pH 7.6; moderately cobbly to slightly to moderately channery; clear, smooth boundary.

Horizon	Depth (cm)	Description
IIBC	25 - 33	Very dark grayish brown to dark brown (10 YR 3/2-3/3) silt loam, grayish brown (10 YR 5/2) when dry; strong, medium granular to weak coarse pseudo platy; friable; pH 7.6; slight effervescence; moderately cobbly to moderately channery; clear, wavy boundary.
IIC	33 - 50 +	Very dark grayish brown (10 YR 3/2) silt loam, gray to grayish brown (10 YR 5/1-5/2) when dry; amorphous to moderate coarse pseudo platy; friable; pH 7.8; strong effervescence; very gravelly to channery.

Sub-group: Orthic Eutric Brunisol

Profile No. M34.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	13-0	6.8	nd	nd	32.5	1.1	nd	5.7	.5	1.6	91.3	.9	118.0	nd
Bf1	0-12	7.7	0.3	2.0	nd	.2	11.3	nd	.5	.9	95.6	3.0	28.0	nd
IIBf2	12-25	7.6	0.2	1.4	nd	.1	14.4	nd	.6	1.2	86.7	11.5	21.0	nd
IIBC	25-33	7.6	1.6	2.1	nd	.1	24.0	nd	.6	1.2	89.6	8.6	14.6	nd
IIC	33-50+	7.8	10.0	nd	nd	nd	nd	nd	.6	.6	98.2	.6	13.4	nd

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	13-0	nd	nd	nd	nd	nd	nd	nd	nd	224.1	124.9	114.6	10.3	17.3	nd	nd	nd
Bf1	0-12	3	27	57	16	3	.69	69.6	123	53.5	35.6	14.6	21.0	6.8	.15	.40	.55
IIBf2	12-25	13	32	51	17	7	.90	65.5	73	33.3	22.6	11.2	11.4	2.6	.11	.21	.32
IIBC	25-33	8	26	54	20	10	1.01	61.3	61	24.9	21.0	8.2	12.8	1.8	.07	.06	.13
IIC	33-50+	22	32	51	17	8	.87	66.8	77	27.4	20.9	7.1	13.8	1.5	.08	.05	.13

Sub-group: .... Brunisolic Gray Luvisol.

Profile number: .... M 35.

Location: .... Snow course #6.

Vegetation: Tree canopy: .... _Picea_ sp., _Abies_ sp..

Understory: .... _Menziesia_ sp..

Ground: .... _Vaccinium_ sp., Moss.

Parent material: .... Colluvium/Aeolian/Till I.

Topography: .... Moderately sloping; aspect NE.

Elevation: .... 5820 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	15 - 0	Organic material in various stages of decomposition.
(Ae)	0 - 3	Reddish brown (5 YR 5/4) silt loam, pale brown to light gray (10 YR 6/3-7/2) when dry; weak, coarse platy; very friable; pH 5.7; abrupt, broken boundary.
II(Bf)	3 - 13	Yellowish brown to brownish yellow (10 YR 5/8-6/6) silt loam, yellow (10 YR 8/6) when dry; weak, coarse platy breaking to strong, medium granular; very friable; pH 6.5; abrupt, smooth to broken boundary.

Horizon	Depth (cm)	Description
IIIAe	13 - 20	Grayish brown to brown (10 YR 5/2-5/3) silt loam, light gray to very pale brown (10 YR 7/2-7/3) when dry; weak, medium platy; friable; pH 5.9; slightly gravelly; clear, smooth boundary.
IIIBt	20 - 29	Dark brown to brown (10 YR 4/3) silty clay loam, light brownish gray to pale brown (10 YR 6/2-6/3) when dry; strong, medium subangular blocky; firm; pH 6.1; moderately angular cobbly; clear, smooth boundary.
IIIBC	29 - 40	Very dark gray to very dark grayish brown (10 YR 3/1-3/2) silt loam, grayish brown (10 YR 5/2) when dry; weak, medium granular to amorphous; friable; pH 6.8; slightly angular gravelly; clear, smooth boundary.
IIIC	40 - 100 +	Very dark gray (10 YR 3/1) loam, dark grayish brown to gray (10 YR 4/2-5/1) when dry; amorphous; firm; pH 7.6; strong effervescence; very angular gravelly to moderately angular cobbly.

Sub-group: Brunisolic Gray Luvisol

Profile No. M35

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-h	15-0	4.5	nd	nd	19.2	.3	nd	55.1	.3	1.5	43.1	.0	92.2	nd
(Ae)	0-3	5.7	nd	nd	1.1	.1	13.0	23.8	1.2	1.2	67.8	6.0	19.9	nd
II(Bf)	3-13	6.5	nd	nd	1.4	.1	14.0	27.6	1.6	1.6	69.2	.0	18.6	nd
IIIAe	13-20	5.9	nd	nd	.7	.1	11.6	13.3	.9	.9	84.9	.0	11.0	nd
IIIBt	20-29	6.1	nd	nd	1.1	.1	12.2	9.4	.6	.6	88.8	.6	17.5	nd
IIIBC	29-40	6.8	nd	nd	1.3	.1	12.9	5.6	.5	.5	93.4	.0	17.0	nd
IIIC	40-100+	7.6	8.1	nd	nd	nd	nd	nd	.0	.0	99.0	.0	12.3	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	15-0	nd	nd	nd	nd	nd	nd	nd	nd	289.3	126.4	83.9	42.5	12.3	nd	nd	nd
(Ae)	0-3	2	22	56	22	8	nd	nd	nd	40.2	28.6	11.2	17.4	2.9	.08	.13	.21
II(Bf)	3-13	1	27	60	13	6	nd	nd	nd	62.8	43.3	12.3	31.0	8.6	.24	.88	1.12
IIIAe	13-20	13	17	62	21	6	nd	nd	nd	27.3	21.7	7.2	14.5	1.5	.04	.03	.07
IIIBt	20-29	5	16	52	32	16	nd	nd	nd	24.8	21.5	11.3	10.2	2.3	.06	.04	.10
IIIBC	29-40	3	18	56	26	14	nd	nd	nd	27.1	20.0	10.4	9.6	2.4	.09	.05	.14
IIIC	40-100+	21	32	46	22	12	nd	nd	nd	20.3	18.5	9.9	8.6	1.5	.07	.04	.11

Sub-group: .... Cumulic Regosol.

Profile number: .... M 36.

Location: .... Late-snow-melt basin near head of Cirque.

Vegetation: Ground: .... *Kobresia* sp., *Carex* sp..

Parent material: .... Colluvium/Aeolian colluvium.

Topography: .... Steeply sloping; aspect NE.

Elevation: .... 7600 ft. M.S.L..

Drainage: .... Imperfect.

Horizon	Depth (cm)	Description
L - F	1 - 0	Organic material in early stages of decomposition.
Ah1	0 - 22	Very dark grayish brown to dark brown (10 YR 3/2-3/3) sandy loam, gray to light gray (10 YR 6/1-7/2) aggregates and brown (10 YR 5/3) crushed when dry; strong, medium granular; very friable; pH 4.7; clear, smooth boundary.
Ah2	22 - 48	Very dark grayish brown to dark brown (10 YR 3/2-3/3) loam, gray to light gray (10 YR 6/1-7/2) aggregates and brown to pale brown (10 YR 5/3-6/3) crushed when dry; weak, coarse platy breaking to strong, medium granular; friable; pH 5.1; abrupt, smooth boundary.
IIC1	48 - 63	Brownish yellow (10 YR 6/6) silt loam, very pale brown to yellow (10 YR 8/4-8/6)

Horizon	Depth (cm)	Description
IIC1	48 - 63	when dry; platy; very friable; pH 5.6; filamentous iron concretions between the lower plates; charcoal fragments scattered throughout; abrupt, smooth boundary.
IIC2	63 - 66	Brownish yellow (10 YR 6/6) silt loam, very pale brown to yellow (10 YR 8/4-8/6) when dry; platy; very friable; pH 5.6; filamentous iron concretions between the plates at the lower boundary; abrupt, smooth boundary.
IIC3	66 - 68	Brownish yellow (10 YR 6/6) silt loam, very pale brown (10 YR 8/4) when dry; platy; very friable; pH 5.6; filamentous iron concretions between the plates at the lower boundary; abrupt, smooth boundary.
IIC4	68 - 71	Idem, except (10 YR 8/3) when dry; pH 5.7.
IIC5	71 - 73	Idem, except (10 YR 8/3) when dry; pH 5.9.
IIC6	73 - 84	Idem, except (10 YR 8/3) when dry; pH 6.1.
IIC7	84 - 90	Idem, except (10 YR 8/3) when dry; pH 5.9.
IIC8	90 - 100 +	Brownish yellow (10 YR 6/6) silt loam, very pale brown (10 YR 8/3) when dry; platy; very friable; pH 5.9;

Sub-group: .... Orthic Regosol (formerly Deorcic Regosol)

Profile number: .... M 37.

Location: .... 0.5 chain S of soil pit #36 near head of Cirque.

Vegetation: Ground: .... *Dryas* sp., *Carex* sp., *Festuca* sp., *Polemonium* sp., *Potentilla* sp..

Parent material: .... Colluvium/Till II.

Topography: .... Steeply sloping; aspect NE.

Elevation: .... 7605 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
Ah	0 - 6	Black to very dark brown (10 YR 2/1-2/2) loam, dark grayish brown to gray (10 YR 4/2-5/1) aggregates and dark grayish brown (10 YR 4/2) crushed when dry; strong, medium granular; friable; pH 5.8; slightly angular gravelly; clear, wavy boundary.
AC	6 - 32	Very dark grayish brown (10 YR 3/2) silt loam, gray to light brownish gray (10 YR 6/1-6/2) aggregates and grayish brown (10 YR 6/2) crushed when dry; strong, coarse granular; very friable; pH 5.3; slightly angular gravelly; clear, smooth boundary.

Horizon	Depth (cm)	Description
IIC	32 - 48 +	Dark brown to dark grayish brown (10 YR 3/3-4/2) loam, gray to light gray (10 YR 6/1) when dry; single grained, friable; pH 5.5; exceedingly angular gravelly.

Sub-group: .... Orthic Regosol.

Profile number:.................. M 38.

Location: .... About 1 chain SSE of soil pit #37.

Vegetation: Ground: .... _Salix_ sp., _Carex_ sp., _Juncus_ sp., Moss, _Achillea_ sp., _Polemonium_ sp..

Parent material: .... Colluvium/Colluvium.

Topography: .... Steeply sloping; aspect NE.

Elevation: .... 7620 ft. M.S.L..

Drainage: .... Imperfect to poor.

Horizon	Depth (cm)	Description
L	17 - 14	Unaltered organic material.
F - H	14 - 0	Organic material in various stages of decomposition.
Ahj	0 - 7	Very dark grayish brown (10 YR 3/2) loam, gray to light gray (10 YR 5/1-6/1) aggregates and gray to grayish brown (10 YR 5/1-5/2) crushed when dry; strong, medium granular; friable; pH 6.8; slightly angular gravelly; clear, wavy boundary.
C	7 - 20	Dark brown to dark grayish brown (10 YR 3/3-4/2) silt loam, grayish brown to gray (10 YR 5/2-6/1) when dry; pseudo-platy; friable; pH 6.5; moderately angular gravelly; abrupt, smooth boundary.

Horizon	Depth (cm)	Description
IIAhjb	20 - 24	Very dark grayish brown (10 YR 3/2) loam, gray to light gray (10 YR 5/1-6/1) aggregates and gray to grayish brown (10 YR 6/1-5/2) crushed when dry; weak, medium granular; friable; pH 6.4; moderately angular gravelly; abrupt, wavy boundary.
IIC	24 - 27	Dark brown to dark grayish brown (10 YR 3/3-4/2) silt loam, grayish brown to gray (10 YR 5/2-6/1) when dry; pseudo-platy; friable; pH 6.4; moderately angular gravelly; abrupt, wavy boundary.
IIIAhjb	27 - 33	Very dark grayish brown (10 YR 3/2) loam, gray to light gray (10 YR 6/1-6/1) aggregates and gray to grayish brown (10 YR 5/1-5/2) crushed when dry; weak, medium granular; friable; moderately angular gravelly; abrupt, wavy boundary.
IIIC	33 - 38	Dark brown to dark grayish brown (10 YR 3/3-4/2) silt loam, grayish brown to gray (10 YR 5/2-6/1) when dry; pseudo-platy; friable; moderately angular gravelly; clear, wavy boundary.
IVC	38 - 50 +	Very dark grayish brown (10 YR 3/2) loam, grayish brown (10 YR 5/2) when dry; single grained; friable; strongly angular gravelly.

APPENDIX II-A

Key to Abbreviations

Slope:

d - moderately sloping	(6 - 9%)
e - strongly sloping	(10 - 15%)
f - steeply sloping	(16 - 30%)
g - very steeply sloping	(31 - 60%)
h - excessively sloping	($>$ 60%)

Internal Drainage:

1 - rapid
2 - well
3 - moderately well
4 - imperfect
5 - poor
6 - very poor

Depth and Nature of Organic Horizons:

P - peat
T - turf
a - L-H $<$ 5 cm
b - L-H $\geq$ 5 cm $<$ 121/2 cm
c - L-H $\geq$ 121/2 cm

Nature of Overlay:

C - colluvium
RC - residual colluvium
Al - alluvium

Parent Material:

T - till
MTI - mixed till I
MTII - mixed till II
C - colluvium
RC - residual colluvium
Sh - shale
Res - residual
R - rock
Al - alluvium
Lac - lacustrine

Order	Great Group	Subgroup	Code	Slope	Inter. Drain.	Depth & Nature Org. Hor.	Depth & Nature Overlay (cm)	Parent Material	Depth Bedrock (cm)	Depth Ah Hor. (cm)	Area (acres)
Luvisolic	Gray Luvisol	Orthic	A 1	f	3	a	C < 15	MTI/T			4
			2	f	3	a	RC < 15	MTII/Res	<90		6
			3	f	3	b	C < 15	MTI/Lac			8
			4	f	3	b	C < 15	MTI			4
			5	f	3	c	C > 15	MTI			3
			6	g	3	b	C < 15	MTI/R	<90		4
			7	g	3	b	C < 15	MTI			2
			8	g	3	b	RC > 15	Al			5
		Dark	B 1	f	3	a	RC > 15	MTII/R	<90		15
			2	f	2	a	C < 15	MTII			3
			3	f	3	b	C < 15	MTI			3
			4	f	3	a	C > 15	MTI/T			27
			5	g	3	b	C > 15	Al			5
			6	f	2	b	C > 15	MTII/Res/R	<90		3
			7	f	2	b	RC < 15	MTII/R	<90		2
			8	f	3	b	RC > 15	MTII/Sh			7
			9	f	2	a	RC > 15	MTII			5
			C 1	f	2	b	RC > 15	MTII			11
			2	g	3	b	C > 15	MTII/Res			8
			3	f	2	a	C > 15	MTII			2
			4	f	2	a	RC < 15	MTI			5
Brunisolic	Eutric Brunisol	Degraded	D 1	e	1	a		RC/R	<90		3
			2	e	3	T	RC < 15	Res/R	<30		4
			3	g	1	a		RC/R	<30		15
			4	f	2	a		Res/R	<30		12
			5	g	1	a		RC/R	<90		13
			6	f	2	b	RC < 15	Res/R	<30		5
			7	d	3	a		T			1
			8	f	1	a		RC/R	<90		7
			9	g	1	c	RC < 15	Res/R	<30		1
			0	g	2	a		RC/R	<30		3

Order	Great Group	Subgroup	Code	Slope	Inter. Drain.	Depth & Nature Org. Hor.	Depth & Nature Overlay (cm)	Parent Material	Depth Bedrock (cm)	Depth Ah Hor. (cm)	Area (acres)
Brunisolic	Eutric Brunisol	Degraded	E 1	f	2	b	RC > 15	MTI/R	< 90		25
			2	g	2	b	C > 15	MTI			7
			3	g	2	a	C < 15	MTII/R	< 90		13
			4	f	2	b		RC/R	< 90		16
			5	f	2	a		RC/T			7
			6	d	3	a	RC < 15	Res/R	< 30		2
			7	g	1	b		RC/R	< 90		2
			8	g	2	a	C < 15	MTI/R	< 90		2
			9	g	3	a	C < 15	MTI			4
			0	f	2	a	RC > 15	MTII			12
			E	e	3	b	RC > 15	MTII/R	< 90		2
Regosolic	Regosol	Orthic	F 1	f	2	T		RC/R	< 30		3
			2	g	2	T		RC/R	< 30		19
			3	d	3	T		RC/R	< 30		2
			4	d	4	T		RC/R	< 30		2
		(formerly Deorcic)	G 1	g	2	T		RC/R	< 30		15
			2	f	2	T		RC/R	< 30		6
			3	d	2	T		RC/R	< 30		6
			4	e	2	T		RC/R	< 30		14
		Cumulic	G 5	g	2	b		RC/R	< 90		2
			6	e	2	T		RC/R	< 90		3
			7	g	2	T		RC/R	< 90		0
			8	g	2	b		RC/MTI/R	< 90		5
Chernozemic	Black	Orthic (Montane)	H 1	d	3	T		RC/R	< 30	< 15	15
			2	e	3	T		RC/R	< 30	< 15	1
			3	f	2	T		RC/R	< 30	< 15	7
			4	d	3	T		Res/R	< 90	> 15	4
			5	g	2	T	C > 15	MTII/R	< 90	> 15	2

Order	Great Group	Subgroup	Code	Slope	Inter. Drain.	Depth & Nature Org. Hor	Depth & Nature Overlay (cm)	Parent Material	Depth Bedrock (cm)	Depth Ah Hor. (cm)	Area (acres)
Chernozemic	Black	Eluviated	I 1	g	1	a		RC/R	<30	<15	2
		(Montane)	2	f	2	T		RC/R	<30	<15	8
			3	f	2	a		RC/R	<90		6
		Orthic	J 1	e	3	T	C <15	T		< 7	0
		(Eroded)	2	d	3	T		Res/R	<90	< 7	5
			3	d	3	T	C <15	T/R	<90	< 7	29
			4	e	3	T		Res/R	<90	< 7	14
			5	f	2	T		RC/R	<30	< 7	5
		(Thin)	K 1	g	2	T		RC/R	<90	<15	15
			2	g	1	T		C/R	<30	<15	42
			3	g	2	T	RC <15	T/R	<90	<15	8
			4	g	2	T		C/R	<90	<15	6
			5	f	2	T	RC >15	T		<15	42
			6	f	2	T	RC <15	T		<15	12
			7	g	2	T		RC/R	<30	<15	2
			8	d	3	T		RC/R	<90	<15	2
			9	f	3	T	RC >15	T		<15	3
			0	d	3	T	C <15	MTI/Res/R	<90	<15	3
			L 1	g	2	a		RC/R	<90	<15	2
			2	g	4	a		RC/R	<90	<15	1
			3	g	3	a	C >15	MTI		<15	1
			4	f	2	a		C		<15	2
		(Thick)	M 1	f	3	T	RC >15	MTII		<30	29
			2	e	2	T	C >15	T		<30	18
			3	e	2	T		C/R	<90	<30	4
			4	g	2	T		C/R	<90	<30	12

Order	Great Group	Subgroup	Code	Slope	Inter. Drain.	Depth & Nature Org. Hor.	Depth & Nature Overlay (cm)	Parent Material	Depth Bedrock (cm)	Depth Ah Hor. (cm)	Area (acres)
Chernozemic	Black	Orthic	M 5	g	2	T		RC/R	<90	<30	4
			6	g	2	T		RC		<30	4
			7	f	2	T	C >15	MTI/T		<30	10
			8	g	3	T	C >15	MTII		<30	6
			9	f	2	T	C >15	T		<30	17
			0	d	3	T	C >15	T		<30	14
			N 1	f	2	T	C >15	T/R	<90	<30	7
			2	e	3	T	C >15	T		<30	11
			3	e	2	T		RC/R	<90	<30	1
			4	g	2	T	RC >15	T		<30	4
			5	e	2	T	RC >15	MTII		<30	7
			6	f	3	T		C		<30	2
			7	e	2	T	C >15	MTI/T		<30	3
			P 1	f	3	b	C >15	MTI		<30	15
			2	f	2	a	C >15	MTI		<30	2
			3	d	2	a	C >15	MTI/T		<30	5
			4	g	3	a	C >15	MTII/R	<90	<30	2
			5	e	3	a	C >15	T		<30	9
			6	e	2	a	C >15	MTI		<30	3
			7	g	3	b	C >15	MTI		<30	4
			8	f	3	a	RC >15	MTII		<30	13
			9	e	2	a		RC/R	<90	<30	1
		(Cumulic)	Q 1	f	2	T		C/R	<90	>30	3
			2	f	3	T		C		>30	13
			3	f	3	T	C >15	MTI		>30	20
			4	g	2	T		RC		>30	16
			5	g	3	T		C/R	<90	>30	8
			6	e	2	T	Al >15	T		>30	3
			7	c	2	T		Al/Al		>30	68

Order	Great Group	Subgroup	Code	Slope	Inter. Drain.	Depth & Nature Org. Hor.	Depth & Nature Overlay (cm)	Parent Material	Depth Bedrock (cm)	Depth Ah Hor. (cm)	Area (acres)
Chernozemic	Black	(Cumulic)	Q 8	f	2	T		Al/Al		> 30	3
			9	e	3	T	RC > 15	MTII		> 30	5
			0	f	3	T	RC > 15	MTII		> 30	2
			Q	d	2	T	Al > 15	C		> 30	4
		Orthic (Cumulic)	R 1	f	2	a	C > 15	MTII		> 30	11
			2	f	3	a	C > 15	MTII		> 30	21
			3	f	3	a	C > 15	MTI		> 30	6
			4	g	2	b	C > 15	MTII		> 30	10
			5	f	2	a		C		> 30	6
			6	f	2	b	C > 15	MTII		> 30	3
			7	g	2	a	C > 15	MTI		> 30	6
			8	f	2	a	C > 15	MTI		> 30	8
			9	f	2	a		RC		> 30	4
			0	g	4	a		RC/R	< 90	> 30	1
		Rego (Cumulic)	S 1	f	3	T	Al > 15	T		< 30	2
			2	e	4	T	Al > 15	C		> 30	13
			3	g	2	T		RC		> 30	2
			4	f	2	T		RC/R	< 90	> 30	5
			5	e	2	T		RC/R	< 90	> 30	0
		Rego, Carb.	T 1	g	2	T		RC/R	< 90	< 30	6
			2	g	2	T		C/R	< 90	< 30	4
		(Cumulic)	T 6	g	2	T		C		> 30	14
	Dark Gray	Orthic (Thin)	U 1	f	1	a		RC/R	< 90	< 15	6
			2	f	2	a	C > 15	Res/R	< 90	< 15	14
			3	f	2	a		RC/R	< 90	< 15	13
			4	f	3	a	C > 15	MTI/T		< 15	2
			5	g	3	a		C/R	< 90	< 15	6
			6	d	2	a	C < 15	T		< 15	5

Order	Great Group	Subgroup	Code	Slope	Inter. Drain.	Depth & Nature Org. Hor.	Depth & Nature Overlay (cm)	Parent Material	Depth Bedrock (cm)	Depth Ah Hor. (cm)	Area (acres)
Chernozemic	Dark Gray	Orthic	U 7	d	3	a		T/R	< 90	< 15	2
		(Thin)	8	d	3	a		Res/R	< 90	< 15	1
			9	g	2	a		RC/R	< 90	< 15	5
			0	f	2	a	C > 15	T		< 15	2
			V 1	f	2	b	C < 15	T/R	< 90	< 15	7
			2	g	4	a		RC/R	< 90	< 15	7
			3	c	2	a		RC/R	< 30	< 15	4
			4	f	4	a		RC/R	< 90	< 15	2
			5	g	3	a	RC > 15	T/R	< 90	< 15	2
			6	g	2	b	RC > 15	MTI/R	< 90	< 15	4
			7	f	2	a	RC < 15	MTII/Res		< 15	4
			8	g	2	b		RC/R	< 90	< 15	8
			9	f	3	b	RC > 15	MTII		< 15	3
			U A	f	2	a	RC < 15	MTI/R	< 90	< 15	12
			B	g	2	a		RC/R	< 90	< 15	11
			C	g	3	a	RC < 15	MTII		< 15	3
			D	g	3	a	RC > 15	T		< 15	2
			E	g	2	a		RC		< 15	5
			V A	f	3	T	RC < 15	MTII/Res		< 15	8
			B	f	3	T	C > 15	MTI		< 15	0
			C	e	3	T	RC > 15	MTII		< 15	2
		(Thick)	W 1	f	2	a	C > 15	MTI		< 30	27
			2	f	2	a		T		< 30	3
			3	e	2	a	C > 15	T		< 30	6
			4	g	2	b		RC		< 30	7
			5	g	2	b		RC/R		< 30	9
			6	f	3	a	C < 15	MTII		< 30	3
			A	g	2	b	C > 15	MTI		< 30	4
			B	f	3	b	C > 15	T		< 30	13
			C	f	2	b	C > 15	T/MTII		< 30	13

Order	Great Group	Subgroup	Code	Slope	Inter. Drain.	Depth & Nature Org. Hor.	Depth & Nature Overlay (cm)	Parent Material	Depth Bedrock (cm)	Depth Ah Hor. (cm)	Area (acres)
Chernozemic	Dark Gray	Orthic (Cumulic)	X 1	g	2	a	C > 15	MTI		> 30	12
			2	g	4	b	RC > 15	MTII/R	< 90	> 30	2
			3	f	4	b		C/R	< 90	> 30	2
			4	g	3	a		RC/R	< 90	> 30	13
			5	f	2	b	C > 15	MTI		> 30	7
			6	f	4	b	C > 15	T		> 30	7
			7	f	3	a	C > 15	MTI		> 30	8
			8	f	2	a	C > 15	T		> 30	4
			9	f	2	b		RC/R	< 90	> 30	1
			0	g	1	a		RC/R	< 90	> 30	3
			A	g	3	T	RC > 15	MTII		> 30	6
			B	g	2	a	C > 15	RC/R	< 90	> 30	6
		Rego (Cumulic)	Y 1	g	2	a		RC		> 90	15
			2	f	1	b		RC		> 30	1
			3	g	2	b		RC		> 30	8
			4	g	2	a	C > 15	MTI		> 30	6
			5	f	2	a		RC		> 30	5
			6	g	2	a		RC/R	< 90	> 30	4
			7	f	2	T		RC/R	< 90	> 30	1
			8	f	2	T		RC		> 30	3
			Y	g	4	a		C/R	< 30	< 15	3
		Rego, Carb. (Cum.)	A	g	2	a		RC		> 30	3
Gleysolic	Humic Gleysol	Regg,Carb. (Cum.)	Z 1	c	5	T		Al/Al/Al		> 30	11
Organic	Humisol	Terric	Z Z	c	6	P		Al			5
Water			30								1

APPENDIX II-B

Key to Appendix II-B

The morphological descriptions and analytical results of the soil profiles sampled in Streeter Creek Basin are presented in order of sampling site sequence. Explanation of abbreviations used are as follows:

Ino. C. - Inorganic Carbon

Org. C. - Organic Carbon

Exch. Acid. - Exchange Acidity

pH Depend. C.E.C. - pH Dependend Cation Exchange Capacity

G - Coarse skeleton ($>$ 2 mm)

S - Sand (2 mm - 50μ)

Si - Silt (50μ - 2 μ)

C - Clay (2μ - .2μ)

FC - Fine clay ($<$ .2μ)

Bulk Dens. - Bulk Density

Por. - Porosity (calculated from bulk density and specific gravity data)

Sat. Cap. - Saturation Capacity

(Theor.) - Theoretical Saturation Capacity (Richards and Wadleigh, 1952)

Avail. Moist. - Available Moisture

Hygr. Moist. - Hygroscopic Moisture

Sub-group: .... Orthic Black.

Profile number: .... S 1.

Location: .... Near Survey Plot #152.

Vegetation: Tree: ....

Shrub: .... <u>Rosa</u> sp., <u>Amelanchier</u> sp., <u>Symphoricarpus</u> sp..

Ground: .... <u>Bromus</u> sp., <u>Stipa</u> sp., <u>Aster</u> sp., <u>Achillea</u> sp., <u>Potentilla</u> sp., <u>Lupinus</u> sp..

Parent material: .... Colluvium/Mixed Till 1/Till.

Topography: .... Steeply sloping; aspect ENE.

Elevation: .... 4590 ft. M.S.L..

Drainage: .... Moderately well.

Horizon	Depth (cm)	Description
L - F	2 - 0	Organic material in various stages of decomposition.
Ah	0 - 20	Black (10 YR 2/1) clay loam, very dark grayish brown (10 YR 3/2) when dry; strong coarse prismatic; friable; pH 6.2; gradual, wavy boundary.
BA	20 - 26	Very dark grayish brown (10 YR 3/2) clay loam, dark grayish brown (10 YR 4/2) when dry; strong, coarse prismatic breaking to strong, coarse subangular blocky; firm; pH 6.1; moderately angular cobbly; clear, smooth boundary.

Horizon	Depth (cm)	Description
IIBm	26 - 55	Brown to dark brown (10 YR 4/3) clay loam, brown to dark brown (10 YR 4/3) when dry; strong, coarse prismatic breaking to strong, coarse subangular blocky; firm; pH 6.6; slightly to moderately angular cobbly; diffuse, wavy boundary.
IIBC	55 - 63	Dark grayish brown (10 YR 4/2) clay loam, light brownish gray to pale brown (10 YR 6/2-6/3) when dry; strong, coarse subangular blocky; friable to firm; pH 7.5; slight effervescence; slightly to moderately angular cobbly; gradual, wavy boundary.
IIC	63 - 96	Dark grayish brown to grayish brown (10 YR 4/2-5/2) clay, light gray (10 YR 7/2) when dry; amorphous; friable to firm; pH 7.5; strong effervescence; slightly angular cobbly; clear, wavy boundary.
IIIC	96 - 150	Brown to grayish brown (10 YR 5/3-5/2) clay loam, light gray to white (10 YR 8/1-7/2) when dry; amorphous; friable; pH 7.6; strong effervescence; slightly angular cobbly.

Sub-group: Orthic Black | Profile No. S1

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	2-0	6.7	nd	nd	12.4	1.10	11.2	4.2	.5	6.4	77.7	11.2	56.4	nd
Ah	0-20	6.2	nd	nd	5.1	.42	12.0	11.4	.7	4.4	79.5	4.0	29.5	nd
BA	20-26	6.1	nd	nd	2.1	.20	10.1	11.2	.4	3.9	72.9	11.6	21.6	nd
IIBm	26-55	6.6	nd	nd	2.3	.15	15.0	3.0	.4	3.0	78.0	15.6	24.1	nd
IIBC	55-63	7.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
IIC	63-96	7.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
IIIC	96-150+	7.6	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	2-0	nd	nd	nd	nd	nd	nd	nd	nd	123.0	53.6	14.0	39.6	5.27	nd	nd	nd
Ah	0-20	1	39	32	29	15	.76	68.0	91	45.1	26.0	12.8	13.2	2.91	nd	nd	nd
BA	20-26	2	39	31	30	18	.90	64.7	72	34.4	21.2	12.5	8.7	2.33	nd	nd	nd
IIBm	26-55	5	31	32	37	18	.99	61.3	62	36.1	23.5	12.4	10.1	3.72	nd	nd	nd
IIBC	55-63	12	27	36	37	16	.98	62.3	63	31.3	20.0	12.3	7.7	2.44	nd	nd	nd
IIC	63-96	4	23	36	41	16	1.22	53.1	43	33.4	22.0	10.2	11.8	2.52	nd	nd	nd
IIIC	96-150+	5	35	33	32	11	1.38	47.5	34	57.9	21.6	17.95	3.65	2.12	nd	nd	nd

Sub-group: .... Orthic Black.

Profile number: .... S 2.

Location: .... Thermisters near Survey Plot #151.

Vegetation: Tree: .... *Populus tremuloides*.

Shrub: .... *Rosa* sp., *Symphoricarpus* sp., *Ribes* sp..

Ground: .... grasses, *Aster* sp..

Parent material: .... Colluvium/Mixed Till 1.

Topography: .... Very steeply sloping; aspect ENE.

Elevation: .... 4520 ft. M.S.L..

Drainage: .... Moderately well.

Horizon	Depth (cm)	Description
L - H	4 - 0	Organic material in various stages of decomposition.
Ah1	0 - 28	Black (10 YR 2/1) clay loam, black (10 YR 2/1) when dry; strong, coarse prismatic breaking to strong, coarse subangular blocky; friable; pH 6.1; gradual, wavy boundary.
Ah2	28 - 47	Black (10 YR 2/1) clay loam, very dark gray to black (10 YR 3/1-2/1) when dry; strong, coarse subangular blocky; friable; pH 6.6; clear, smooth boundary.
Bm	47 - 74	Dark brown to brown (10 YR 4/3) clay loam, brown (10 YR 5/3) when dry; strong, medium subangular blocky; firm; pH 6.7;

Horizon	Depth (cm)	Description
Bm	47 - 74	slightly angular gravelly; gradual, smooth boundary.
IIBC	74 - 90	Brown to dark grayish brown (10 YR 4/3-4/2) clay loam, pale brown to brown (10 YR 6/3-5/3) when dry; weak, medium sub-angular blocky to amorphous; friable to firm; pH 7.5; slight effervescence; slightly angular cobbly; gradual, smooth boundary.
IIC	90 - 150 +	Pale brown to brown (10 YR 6/3-5/3) clay loam to clay, light gray to white (10 YR 7/2-8/1) when dry; amorphous; friable to firm; pH 7.6; strong effervescence; slightly to moderately angular cobbly to stony.

Sub-group: Orthic Black

Profile No. S2

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	4-0	6.5	nd	nd	22.5	1.39	16.0	10.4	.3	3.6	70.7	15.0	32.8	nd
Ah1	0-28	6.1	nd	nd	4.8	1.56	3.1	8.3	.3	5.0	67.8	18.6	36.0	nd
Ah2	28-47	6.6	nd	nd	3.2	.28	11.6	4.0	.3	3.1	67.3	25.3	30.1	nd
Bm	47-74	6.7	nd	nd	1.1	.12	9.3	1.9	.7	3.0	67.0	27.4	23.8	nd
IIBC	74-90	7.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
IIC	90-150+	7.6	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	4-0	nd	nd	nd	nd	nd	nd	nd	nd	167.1	81.6	47.4	34.2	7.39	nd	nd	nd
Ah1	0-28	1	26	37	37	21	.89	62.4	70	21.7	31.3	15.6	15.7	3.63	nd	nd	nd
Ah2	28-47	3	25	36	39	21	1.06	57.9	54	15.2	27.5	16.6	10.9	3.16	nd	nd	nd
Bm	47-74	7	27	40	33	12	1.18	54.1	46	67.6	24.3	13.0	11.3	2.74	nd	nd	nd
IIBC	74-90	7	26	38	36	12	1.15	55.4	48	32.1	21.5	10.1	11.4	2.41	nd	nd	nd
IIC	90-150+	4	23	37	40	16	1.27	51.9	41	28.6	18.8	10.1	8.7	2.03	nd	nd	nd

Sub-group: .... Orthic Black.

Profile number: .... S 3.

Location: .... Near Survey Plot #47.

Vegetation: Tree: ....

Shrub: .... Salix sp..

Ground: .... Phleum sp., Stipa sp., Geranium sp..

Parent material: .... Colluvium/Colluvium.

Topography: .... Strongly sloping; aspect W..

Elevation: .... 4530 ft. M.S.L..

Drainage: .... Moderately well.

Horizon	Depth (cm)	Description
L - F	3 - 0	Organic material in early stages of decomposition.
Ah1	0 - 25	Black (10 YR 2/1) clay, black (10 YR 2/1) when dry; strong, very coarse prismatic; firm; pH 6.9; clear, smooth boundary.
Ah2	25 - 59	Black (10 YR 2/1) clay, very dark gray (10 YR 3/1) when dry; strong, very coarse prismatic to moderate, coarse subangular blocky; firm; pH 6.5; clear, smooth boundary.
AB	59 - 76	Black (10 YR 2/1) clay loam, dark grayish brown (10 YR 4/2) when dry; strong, coarse subangular blocky; firm; pH 6.6; abrupt, smooth boundary.

Horizon	Depth (cm)	Description
Bm	76 - 88	Very dark grayish brown (10 YR 3/2) loam to clay loam, grayish brown (10 YR 5/2) when dry; strong, very coarse subangular blocky; friable; pH 6.9; clear, smooth boundary.
IIBC	88 - 99	Dark brown (10 YR 3/3) loam, brown (10 YR 5/3) when dry; weak, coarse subangular blocky to amorphous; friable; pH 7.3; slight effervescence; moderately channery; gradual, smooth boundary.
IIC	99 - 120 +	Very dark grayish brown (10 YR 3/2) loam, light gray to gray (10 YR 6/1) when dry; amorphous; friable; pH 7.8; strong effervescence; moderately channery.

Sub-group: Orthic Black

Profile No. S3

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	3-0	6.9	nd	nd	9.2	.69	13.5	nd	.4	5.1	79.4	15.1	38.5	nd
Ah1	0-25	6.4	nd	nd	6.5	.60	10.9	11.3	.2	3.0	70.7	14.8	37.6	nd
Ah2	25-59	6.5	nd	nd	2.9	.31	9.3	6.9	.6	1.8	73.3	17.4	29.8	nd
AB'	59-76	6.6	nd	nd	1.8	.22	8.5	5.3	.7	1.8	70.3	21.9	25.1	nd
Bm	76-88	6.9	nd	nd	1.6	.11	13.7	3.0	.9	2.2	72.3	21.6	19.8	nd
IIBC	88-99	7.3	nd	nd	nd	nd	nd	nd	1.0	2.0	65.2	31.8	12.4	nd
IIC	99-120+	7.8	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	3-0	nd	nd	nd	nd	nd	nd	nd	nd	73.6	40.4	18.2	22.2	3.85	nd	nd	nd
Ah1	0-25	0	35	17	48	16	nd	nd	nd	57.5	33.3	21.6	12.2	3.80	nd	nd	nd
Ah2	25-59	1	32	27	41	14	nd	nd	nd	38.1	27.0	15.8	11.2	2.75	nd	nd	nd
AB	59-76	1	34	38	28	12	nd	nd	nd	36.3	24.2	13.1	11.1	2.59	nd	nd	nd
Bm	76-88	1	31	42	27	12	nd	nd	nd	28.5	19.9	10.8	9.1	2.04	nd	nd	nd
IIBC	88-99	3	45	36	19	7	nd	nd	nd	23.8	16.1	7.4	8.7	1.48	nd	nd	nd
IIC	99-120+	9	47	37	16	6	nd	nd	nd	21.6	13.3	5.3	8.0	1.07	nd	nd	nd

Sub-group: .... Orthic Black.

Profile number: .... S 4.

Location: .... Near Survey Plot #200.

Vegetation: .... *Bromus* sp., *Koeleria* sp., *Festuca* sp., *Lupinus* sp., *Geranium* sp., *Aster* sp., *Glycorrhiza* sp..

Parent material: .... Colluvium/Mixed Till I/Till.

Topography: .... Steeply sloping; aspect E.

Elevation: .... 5020 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - F	1 - 0	Organic material in early stages of decomposition.
Ah	0 - 25	Black (10 YR 2/1) clay loam, very dark gray (10 YR 3/1) when dry; strong, coarse prismatic; friable; pH 6.1; clear, wavy boundary.
AB	25 - 33	Very dark grayish brown (10 YR 3/2) clay loam, brown to dark brown (10 YR 4/3) when dry; strong, medium prismatic; friable; pH 5.7; gradual, wavy boundary.
IIBm1	33 - 56	Brown to dark brown (10 YR 4/3) clay to silty clay, brown (10 YR 5/3) when dry; weak, coarse prismatic breaking to strong, medium subangular blocky; firm;

Horizon	Depth (cm)	Description
IIBm1	33 - 56	pH 5.8; gradual, wavy boundary.
IIBm2	56 - 75	Brown to dark brown (10 YR 4/3) silty clay, yellowish brown to light yellowish brown (10 YR 5/4-6/4) when dry; strong, medium subangular blocky; firm; pH 5.7; gradual, wavy boundary.
IIBC1	75 - 87	Grayish brown (10 YR 5/2) silty clay, light yellowish brown (10 YR 6/4) when dry; strong, fine subangular blocky; firm; pH 5.9; clear, wavy boundary.
IIIBC2	87 - 101	Grayish brown (10 YR 5/2) silty clay loam, light yellowish brown to very pale brown (10 YR 4/4-7/3) when dry; amorphous; friable; pH 6.1 .
IIIC	101+	Not sampled.

Sub-group: Orthic Black

Profile No. S4

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-F	1-0	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ah	0-25	6.1	nd	nd	5.85	.49	11.9	17.2	.2	5.1	76.2	1.3	33.1	nd
AE	25-33	5.7	nd	nd	2.57	.20	12.8	19.4	.4	3.7	75.8	.7	20.3	nd
IIBm1	33-56	5.8	nd	nd	1.83	.14	13.3	12.5	.3	3.0	81.2	3.0	22.0	nd
IIBm2	56-75	5.7.	nd	nd	1.46	.09	15.5	10.3	.3	2.5	85.2	1.7	21.7	nd
IIBC1	75-87	5.9	nd	nd	.81	.08	10.3	7.0	.3	1.8	83.0	7.9	24.0	nd
IIIBC2	87-101	6.1	nd	nd	.86	.08	11.5	5.9	.4	1.8	87.6	4.3	21.6	nd
IIIC	101+													

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-F	1-0	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
Ah	0-25	0	26	39	35	20	nd	nd	nd	59.1	28.2	21.4	6.8	6.6	.07	.09	.16
AB	25-33	2	29	38	33	18	nd	nd	nd	36.7	22.4	14.4	8.0	2.7	.06	.11	.17
IIBm1	33-56	0	19	40	41	21	nd	nd	nd	33.8	22.1	13.7	8.4	2.9	.05	.10	.15
IIBm2	56-75	8	14	45	41	21	nd	nd	nd	30.5	21.2	14.5	6.7	3.2	.04	.07	.11
IIBC1	75-87	6	5	50	45	19	nd	nd	nd	32.8	24.1	13.8	10.3	3.1	.03	.03	.06
IIIBC2	87-101	2	13	51	36	17	nd	nd	nd	38.5	22.5	13.2	9.3	2.7	.04	.04	.08
IIIC	101+																

Sub-group: .... Degraded Eutric Brunisol.

Profile number: .... S 5.

Location: .... Near Survey Plot #201.

Vegetation: Tree: .... _Populus tremuloides_.

Ground: .... _Bromus_ sp., _Poa_ sp., _Festuca_ sp., _Aster_ sp., _Geranium_ sp., _Thalictrum_ sp..

Parent material: .... Colluvium/Till/Residual/Rock.

Topography: .... Moderately sloping; aspect SE.

Elevation: .... 5050 ft. M.S.L.

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	2 - 0	Organic material in various stages of decomposition.
Aeh	0 - 10	Very dark gray to dark gray (10 YR 3/1-4/1) loam to clay loam, dark brown to brown (10 YR 4/3-5/3) when dry; strong, medium prismatic; firm; pH 5.7; clear, wavy boundary.
IIBm1	10 - 29	Dark brown to brown (10 YR 3/3-4/3) clay loam, brown to yellowish brown (10 YR 5/3-5/4) when dry; strong, medium sub-angular blocky; firm; pH 5.5; gradual, wavy boundary.
IIBm2	29 - 49	Grayish brown to brown (10 YR 5/2-4/3) clay loam, yellowish brown (10 YR 5/4) when dry; strong, medium subangular

Horizon	Depth (cm)	Description
IIBm2	29 - 49	blocky; firm; pH 5.8; gradual, wavy boundary.
IIBC	49 - 62	Grayish brown to brown (10 YR 5/2-5/3) clay loam, light yellowish brown (10 YR 6/4) when dry; strong, fine subangular blocky; firm; pH 6.8; clear, wavy boundary.
IIIC	62 - 90	Gray to grayish brown (10 YR 5/1-5/2) loam, very pale brown (10 YR 7/3-7/4) when dry; amorphous; friable; pH 7.5; strong effervescence; diffuse, broken boundary.
Rock	90 +	

Sub-group: Degraded Eutric Brunisol Profile No. S5

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	2-0	6.9	nd	nd	27.33	1.97	nd	5.9	.1	3.3	90.7	.0	90.5	nd
Aeh	0-10	5.7	nd	nd	5.49	.33	16.5	20.0	.1	5.6	71.4	2.9	25.4	nd
IIBm1	10-29	5.5	nd	nd	2.70	.17	16.3	15.6	.2	3.7	78.2	2.3	21.0	nd
IIBm2	29-49	5.8	nd	nd	1.64	.10	16.4	10.1	.2	2.9	83.0	3.8	20.5	nd
IIBC	49-62	6.8	nd	nd	2.07	.09	23.3	1.6	.2	1.6	96.6	.0	17.8	nd
IIIC	62-90	7.5	nd	nd	nd	nd	nd	nd	.1	.8	99.1	.0	12.9	nd
Rock	90+													

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	2-0	nd	nd	nd	nd	nd	nd	nd	nd	231.0	129.8	106.0	23.8	10.4	nd	nd	nd
Aeh	0-10	0	35	38	27	18	nd	nd	nd	49.5	30.4	19.7	10.7	3.0	.06	.07	.13
IIBm1	10-29	6	29	38	33	22	nd	nd	nd	40.2	25.1	16.0	9.1	3.1	.05	.09	.14
IIBm2	29-49	2	29	38	33	19	nd	nd	nd	33.7	22.6	13.7	8.9	2.7	.03	.07	.10
IIBC	49-62	1	25	42	33	16	nd	nd	nd	33.7	21.1	11.9	9.2	2.1	.03	.06	.09
IIIC	62-90	4	27	47	26	15	nd	nd	nd	29.4	19.7	10.3	9.4	1.8	.03	.02	.05
Rock	90+																

Sub-group: .... Degraded Eutric Brunisol (with Overlay).

Profile number: .... S 6.

Location: .... Near Survey Plot #205.

Vegetation: Tree: .... *Populus* sp..

Shrub: .... *Rubus* sp., *Salix* sp., *Symphoricarpus* sp..

Ground: .... *Epilobium* sp., *Delphinium* sp., *Viola* sp., *Vicia* sp., *Calamagrostis* sp..

Parent material: .... Residual Colluvium/Residual/Rock.

Topography: .... Steeply sloping; aspect ESE.

Elevation: .... 5100 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	8 - 0	Organic material in various stages of decomposition.
Aeh	0 - 13	Black to dark brown (10 YR 4/3-2/1) loam, very dark gray to dark grayish brown (10 YR 3/1-4/2) when dry; weak, fine subangular blocky; friable; pH 5.6; clear, wavy boundary.
Bm	13 - 27	Dark brown to brown (10 YR 4/3-5/3) sandy clay loam, yellowish brown (10 YR 5/4) when dry; strong, coarse subangular blocky; firm; pH 5.4; gradual, irregular boundary.
IIBC	27 - 43	Yellowish brown (10 YR 5/4) sandy loam, pale brown to light yellowish brown (10

Horizon	Depth (cm)	Description
IIBC	27 - 43	YR 6/3-6/4) when dry; single grained; very friable; pH 5.5; diffuse, broken boundary.
R	43 +	

Sub-group: Degraded Eutric Brunisol (with Overlay) Profile No. S6

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis						pH-depend. C.E.C.
								exch. acid.	Na	K	Ca	Mg	TEC	
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	8-0	6.5	nd	nd	28.92	1.57	nd	5.8	.1	2.6	78.4	13.1	112.0	nd
Aeh	0-13	5.6	nd	nd	3.76	.20	18.6	19.2	.4	2.8	75.8	1.8	21.0	nd
Bm	13-27	5.4	nd	nd	1.56	.09	17.9	18.8	.4	2.1	71.2	7.5	15.4	nd
IIBC	27-43	5.5	nd	nd	1.33	.06	24.2	21.3	.6	2.8	65.9	9.4	9.6	nd
Rock														

Horizon	Depth	Mechanical Analysis					Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis					Free R_2O_3 (Oxalate)		
		G	S	Si	C	FC				Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	8-0	nd	nd	nd	nd	nd	nd	nd	nd	221.3	113.8	96.9	16.9	8.7	nd	nd	nd
Aeh	0-13	0	49	32	19	12	nd	nd	nd	39.3	20.9	13.3	7.6	2.4	.08	.08	.16
Bm	13-27	10	52	27	21	13	nd	nd	nd	31.5	17.1	11.5	5.6	1.8	.04	.07	.11
IIBC	27-43	42	65	21	14	8	nd	nd	nd	nd	13.2	nd	nd	1.0	.04	.07	.11
Rock																	

Sub-group: .... Orthic Dark Gray (with Overlay).

Profile number: .... S 7.

Location: .... Near Survey Plot #189.

Vegetation: Tree: .... Populus tremuloides.

Shrub: .... Salix sp., Betula sp..

Ground: .... Epilobium sp., Geranium sp., Aster sp., Calamagrostis sp..

Parent material: .... Colluvium/Colluvium/Residual/Rock.

Topography: .... Steeply sloping; aspect S.

Elevation: .... 4890 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - F	2 - 0	Organic material in early stages of decomposition.
Ah1	0 - 4	Very dark brown (10 YR 2/2) loam, very dark brown to very dark gray (10 YR 2/2-3/1) when dry; strong, medium granular; friable; pH 6.1; slightly channery; abrupt, smooth boundary.
IIAh2	4 - 15	Very dark brown (10 YR 2/2) loam, dark grayish brown (10 YR 4/2) when dry; strong, medium prismatic; friable; pH 6.0; slightly channery; clear, wavy boundary.
IIAB	15 - 40	Dark brown (10 YR 3/3) loam, brown to pale brown (10 YR 5/3-6/3) when dry;

Horizon	Depth (cm)	Description
IIAB	15 - 40	strong, medium prismatic; friable; pH 5.9; slightly to moderately channery; clear, irregular boundary.
IIIBm	40 - 62	Brown to yellowish brown (10 YR 4/3-5/4) sandy loam, yellowish brown to light yellowish brown (10 YR 5/4-6/4) when dry; strong, medium subangular blocky; very friable; pH 6.0; moderately channery; clear, irregular boundary.
IIIC	62 - 80	Brown to dark brown (10 YR 4/3) sandy loam, yellowish brown (10 YR 5/4) when dry; amorphous; very friable; pH 6.0; very to exceedingly channery; abrupt, broken boundary.
R	80 +	

Sub-group: Orthic Dark Gray (with Overlay) Profile No. S7

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	2-0	6.5	nd	nd	25.4	1.54	nd	8.2	.2	4.5	86.8	.3	76.0	nd
Ah	0-4	6.1	nd	nd	7.82	.53	14.8	14.9	.1	7.3	76.6	1.1	32.0	nd
IIAh2	4-15	6.0	nd	nd	3.72	.27	14.0	18.8	.1	5.7	75.4		22.4	nd
IIAB	15-40	5.9	nd	nd	1.32	.12	11.3	14.9	.2	5.5	71.9	7.5	13.4	nd
IIIBm	40-62	6.0	nd	nd	.73	.05	14.9	11.7	.2	4.5	75.8	7.8	11.0	nd
IIIC	62-75+	6.0	nd	nd	nd	nd	nd	13.7	.1	4.3	73.8	8.1	8.0	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	2-0	nd	nd	nd	nd	nd	nd	nd	nd	214.2	100.0	70.7	29.3	8.1	nd	nd	nd
Ah1	0-4	0	32	45	23	7	nd	nd	nd	67.4	37.1	28.9	8.2	5.3	.07	.07	.14
IIAh2	4-15	3	34	40	26	11	nd	nd	nd	41.5	24.7	16.8	7.9	4.5	.07	.07	.14
IIAB	15-40	1	39	41	20	6	nd	nd	nd	29.6	18.8	9.3	9.5	2.3	.05	.06	.11
IIIBm	40-62	19	58	23	19	10	nd	nd	nd	25.9	16.4	9.4	7.0	1.3	.05	.03	.08
IIIC	62-75+	38	63	23	4	8	nd	nd	nd	23.5	13.0	6.7	6.3	0.8	.04	.04	.08

Sub-group: .... Degraded Eutric Brunisol.

Profile number: .... S 8.

Location: .... Near Survey Plot #139.

Vegetation: Tree: .... Populus tremuloides.

Shrub: .... Salix sp., Rosa sp..

Ground: .... Aster sp., Epilobium sp., Thalictrum sp., Vicia sp., Fragaria sp..

Parent material: .... Colluvium/Till/Rock.

Topography: .... Steeply sloping; aspect N.

Elevation: .... 4739 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L	7 - 6	Undecayed organic material.
F - H	6 - 0	Partially and fully decayed organic materially.
Ah	0 - 4	Black (10 YR 2/1) loam, very dark gray (10 YR 3/1) when dry; weak, fine prismatic breaking to strong, coarse granular; friable; pH 6.0; abrupt, wavy boundary.
Aej	4 - 12	Brown to dark brown (10 YR 4/3) sandy loam to loam, brownish gray to very pale brown (10 YR 6/2-7/3) when dry; weak, coarse platy to strong, fine subangular blocky; very friable; pH 6.0; slightly to moderately channery; clear, wavy boundary.

Horizon	Depth (cm)	Description
Bm	12 - 44	Brown to dark yellowish brown (10 YR 4/3-4/4) sandy loam, light yellowish brown (10 YR 6/4) when dry; strong, medium, subangular blocky; very friable; pH 6.0; slightly to moderately channery; clear, smooth boundary.
IIACb	44 - 65	Dark gray to grayish brown (10 YR 4/1-5/2) clay loam, light brownish gray to pale brown (10 YR 6/2-6/3) when dry; strong, coarse subangular blocky; firm; pH 7.0; moderately angular gravelly to angular cobbly; clear, smooth boundary.
IIC	65 - 80	Grayish brown to brown (10 YR 5/2-5/3) clay loam, grayish brown to light brownish gray (10 YR 5/2-6/2) when dry; amorphous; firm; pH 7.5; strong effervescence; moderately angular gravelly to angular cobbly; abrupt, broken boundary.
R	80 +	

Sub-group: Degraded Eutric Brunisol

Profile No. S8

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L	7-6	6.4	nd	nd	43.4	1.7	nd	10.9	.1	5.2	78.0	5.8	102.4	nd
F-h	6-0	6.2	nd	nd	34.6	1.8	nd	10.4	.1	4.2	85.3	.0	112.4	nd
Ah	0-4	6.0	nd	nd	11.0	.7	15.1	20.3	.1	5.0	74.6	.0	42.2	nd
Aej	4-12	6.0	nd	nd	1.1	.1	15.1	18.1	.0	4.8	71.1	6.0	9.3	nd
Bm	12-44	6.0	nd	nd	.8	.1	13.6	14.3	.0	3.3	69.2	13.2	9.9	nd
IIACb	44-65	7.0	nd	nd	1.3	.1	15.8	1.8	.0	1.4	92.2	4.6	19.5	nd
IIC	65-80	7.5	11.1	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
R														

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L	7-6	nd	nd	nd	nd	nd	nd	nd	nd	nd	150.1	119.0	31.1	10.3	nd	nd	nd
F-H	6-0	nd	nd	nd	nd	nd	nd	nd	nd	259.3	137.9	76.4	61.5	15.3	nd	nd	nd
Ah	0-4	0	45	35	20	6	nd	nd	nd	94.3	43.6	29.9	13.7	3.6	.07	.06	.13
Aej	4-12	0	51	33	16	7	nd	nd	nd	27.0	15.0	6.7	8.3	1.0	.04	.03	.07
Bm	12-44	0	57	26	17	11	nd	nd	nd	21.7	15.7	8.8	6.9	2.0	.04	.05	.09
IIACb	44-65	4	37	33	30	16	nd	nd	nd	31.4	20.8	12.8	8.0	3.5	.04	.06	.10
IIC	65-80	13	33	37	30	15	nd	nd	nd	29.1	18.6	10.2	8.4	2.6	.04	.05	.09
R																	

Sub-group: .... Orthic Dark Gray with Overlay.

Profile number: .... S 9.

Location: .... Near Survey Plot #153.

Vegetation: Tree: .... Populus tremuloides.

Shrub: .... Salix sp., Emelanchier sp., Betula sp., Rosa sp..

Ground: .... Epilobium sp., Aster sp., Calamagrostis sp..

Parent material: .... Colluvium/Colluvium/Mixed Till 1.

Topography: .... Steeply sloping; aspect SSE.

Elevation: .... 4575 ft.

Drainage: .... Moderately well.

Horizon	Depth (cm)	Description
L - H	6 - 0	Organic material in various stages of decomposition.
Ahj	0 - 6	Very dark grayish brown (10 YR 3/2) loam, dark gray (10 YR 4/1) when dry; strong, medium prismatic; friable; pH 6.1; clear, wavy boundary.
IIAh	6 - 20	Very dark gray (10 YR 3/1) loam, dark grayish brown (10 YR 4/2) when dry; strong, medium prismatic; friable; pH 6.0; clear, irregular boundary.
IIBm1	20 - 42	Dark brown to brown (10 YR 3/3-4/3) clay loam, brown to pale brown (10 YR 5/3-6/3) when dry; strong, fine prismatic to moderate, medium subangular blocky; firm;

Horizon	Depth (cm)	Description
IIBm1	20 - 42	pH 5.7; gradual, wavy boundary.
IIIBm2	42 - 64	Brown to dark brown (10 YR 4/3) clay loam, yellowish brown (10 YR 5/4) when dry; slightly angular gravelly; strong medium subangular blocky; firm; pH 5.6; gradual, wavy boundary.
IIIBC	64 - 86	Grayish brown to brown (10 YR 5/2-4/3) clay loam, light brownish gray to pale brown (10 YR 6/2-6/3) when dry; strong, medium subangular blocky; firm; pH 6.2; moderately angular cobbly to angular gravelly; clear, smooth boundary.
IIIC	86 - 96 +	Dark grayish brown to grayish brown (10 YR 4/2-5/2) silty clay loam, grayish brown to light brownish gray (10 YR 5/2-6/2) when dry; amorphous; firm; pH 7.4; strong effervescence; moderately angular cobbly to angular gravelly.

Sub-group: Orthic Dark Gray (with Overlay) Profile No. S9

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	6-0	6.3	nd	nd	27.8	1.63	nd	16.0	.2	1.7	70.6	11.5	97.7	nd
Ahj	0-6	6.1	nd	nd	3.9	.30	12.8	14.9	.0	2.1	75.0	8.0	27.9	nd
IIAh	6-20	6.0	nd	nd	2.8	.25	11.4	13.6	.0	3.5	73.7	9.2	24.5	nd
IIBml	20-42	5.7	nd	nd	1.0	.08	12.0	8.6	.0	7.1	80.2	4.1	20.3	nd
IIIBm2	42-64	5.6	nd	nd	.7	.07	9.7	7.1	.0	9.5	81.5	1.9	21.2	nd
IIIBC	64-86	6.2	nd	nd	.6	.05	10.5	2.5	.0	3.5	94.0	.0	20.5	nd
IIIC	86-96+	7.4	8.2	nd	nd	nd	nd	nd	.3	.8	98.9	.0	19.8	nd

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	6-0	nd	nd	nd	nd	nd	nd	nd	nd	236.2	105.4	87.6	17.8	16.5	nd	nd	nd
Ahj	0-6	0	25	48	27	12	nd	nd	nd	34.5	31.2	15.8	15.4	3.0	.07	.06	.13
IIAh	6-20	1	28	46	26	13	nd	nd	nd	41.3	25.2	15.0	10.2	4.2	.07	.03	.10
IIIBml	20-42	4	30	34	36	21	nd	nd	nd	32.7	23.2	14.0	9.2	3.8	.05	.03	.08
IIIBm2	42-64	5	30	34	36	21	nd	nd	nd	33.4	21.4	13.0	8.4	3.9	.04	.03	.07
IIIBC	64-86	3	31	35	34	19	nd	nd	nd	35.9	21.5	13.6	7.9	3.9	.04	.07	.11
IIIC	86-96+	1	19	45	36	16	nd	nd	nd	33.4	22.8	12.8	10.0	3.5	.04	.07	.11

Sub-group: .... Dark Gray Luvisol.

Profile number: .... S 10.

Location: .... Near Survey Plot #137.

Vegetation: Tree: .... _Populus_ sp., _Pseudotsuga_ sp..

Shrub: .... _Betula_ sp., _Spiraea_ sp., _Rosa_ sp., _Betula_ sp..

Ground: .... _Aster_ sp., _Fragaria_ sp., _Epilobium_ sp., _Calamagrostis_ sp..

Parent material: .... Colluvium/Mixed Till II/Residual/Rock.

Topography: .... Very steeply sloping; aspect NE.

Elevation: .... 4730 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	5 - 0	Organic material in various stages of decomposition.
Ahe	0 - 9	Very dark grayish brown (10 YR 3/2) clay loam, dark gray to dark grayish brown (10 YR 4/1-4/2) when dry; weak, coarse prismatic breaking to strong, medium granular; friable; pH 5.8; abrupt, wavy boundary.
Ae	9 - 14	Dark brown to brown (10 YR 4/3) loam, light yellowish brown (10 YR 6/4) when dry; weak, coarse platy; friable; pH 5.7; clear, wavy boundary.

Horizon	Depth (cm)	Description
IIAB	14 - 22	Yellowish brown (10 YR 5/4) clay loam, yellowish brown (10 YR 5/4) when dry; strong, coarse subangular blocky; firm; pH 5.8; slightly channery; clear, wavy boundary.
IIBt	22 - 38	Yellowish brown (10 YR 5/4) clay loam to clay, yellowish brown to light yellowish brown (10 YR 5/4-6/4) when dry; strong, coarse subangular blocky; firm; pH 5.5; moderately channery; clear, wavy boundary.
IIBC	38 - 57	Brown (10 YR 5/3)clay, yellowish brown to light yellowish brown (10 YR 5/4-6/4) when dry; strong, coarse subangular blocky; firm; pH 6.0; very channery; abrupt, smooth boundary.
IIIC	57 - 66	Dark brown to brown (10 YR 4/3) sandy loam, pale brown (10 YR 6/3) when dry; single grained; very friable; pH 7.6; slight effervescence; very to exceedingly channery; abrupt, irregular boundary.
Rock	66 +	

Sub group: Dark Gray Luvisol

Profile No. S10.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	5-0	6.6	nd	nd	21.5	1.3	nd	8.6	.1	2.4	87.9	1.0	82.6	nd
Ahe	0-9	5.8	nd	nd	3.6	.2	18.3	23.5	.5	2.5	69.1	4.4	22.9	nd
Ae	9-14	5.7	nd	nd	1.2	.1	14.7	16.0	.0	2.4	76.8	4.8	14.3	nd
IIAB	14-22	5.8	nd	nd	1.0	.1	15.1	11.0	.6	2.9	74.5	11.0	20.4	nd
IIBt	22-38	5.5	nd	nd	1.1	.1	16.3	9.1	.5	1.9	81.3	7.2	24.4	nd
IIBC	38-57	6.0	nd	nd	1.1	.1	18.6	6.4	.5	1.4	83.9	7.8	25.6	nd
IIIC	57-66	7.6	2.4	nd	nd		nd	nd	nd	nd	nd	nd	9.2	nd
R	66+	nd	nd	nd	nd		nd	nd	nd	nd	nd	nd	nd	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	5-0	nd	nd	nd	nd	nd	nd	nd	nd	175.4	68.9	51.3	17.6	9.3	nd	nd	nd
Ahe	0-9	0	43	29	28	16	nd	nd	nd	42.0	20.4	13.7	6.7	2.5	nd	nd	nd
Ae	9-14	1	41	37	22	11	nd	nd	nd	27.5	16.7	8.8	7.9	1.7	nd	nd	nd
IIAB	14-22	1	26	39	35	20	nd	nd	nd	30.9	20.5	13.6	6.9	2.9	nd	nd	nd
IIBt	22-38	3	22	38	40	23	nd	nd	nd	35.1	22.2	15.3	6.9	4.6	nd	nd	nd
IIBC	38-57	0	22	34	44	20	nd	nd	nd	33.5	22.8	14.7	8.1	3.5	nd	nd	nd
IIIC	57-66	6	59	26	15	8	nd	nd	nd	21.9	14.2	7.5	6.7	1.8	nd	nd	nd
R	66+	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Sub-group: .... Carbonated Orthic Dark Gray (with Overlay).

Profile number: .... S 11.

Location: .... Near Survey Plot #10.

Vegetation: Tree: .... Populus tremuloides.

Shrub: .... Symphoricarpus sp., Rosa sp..

Ground: .... Calamagrostis sp., Aster sp., Disporum sp..

Parent material: .... Coll/Till/Mixed Till II.

Topography: .... Steeply sloping; aspect N.

Elevation: .... 4780 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	2 - 0	Organic material in various stages of decomposition.
Ah1	0 - 7	Dark brown (10 YR 3/3) loam, grayish brown (10 YR 5/2) when dry; strong, medium subangular blocky; friable; pH 7.6; strong effervescence; abrupt, smooth boundary.
IIAh2	7 - 24	Dark grayish brown (10 YR 4/2) clay loam, grayish brown (10 YR 5/2) when dry; strong, medium to coarse prismatic; friable; pH 7.7; strong effervescence; slightly angular gravelly; clear, wavy boundary.
IIBm	24 - 45	Brown to yellowish brown (10 YR 5/3-5/4) clay loam, yellowish brown (10 YR 5/4)

Horizon	Depth (cm)	Description
IIBm	24 - 45	when dry; strong, medium subangular blocky; firm; pH 7.7; slight effervescence; moderately gravelly; abrupt, wavy boundary.
IIBC	45 - 58	Grayish brown (10 YR 5/2) clay loam, light brownish gray to pale brown (10 YR 6/2-6/3) when dry; strong, medium subangular blocky; firm; pH 7.9; strong effervescence; very angular cobbly; abrupt, wavy boundary.
IIC	58 - 76	Brown to pale brown (10 YR 5/3-6/3) clay loam to silty clay loam, very pale brown (10 YR 8/3-8/4) when dry; amorphous; firm; pH 8.0; strong effervescence; moderately channery; abrupt, smooth boundary.
IIIC	76 - 100 +	Light yellowish to very pale brown (10 YR 6/4-7/4) silty clay loam, very pale brown (10 YR 8/4) when dry; amorphous; friable; pH 8.2; strong effervescence.

Sub-group: Carbonated Orthic Dark Gray (with Overlay) Profile No. S11

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis						pH-depend. C.E.C.
								exch. acid.	Na	K	Ca	Mg	TEC	
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	2-0	6.7	nd	nd	37.7	1.6	nd	8.6	.1	1.1	86.1	1.4	43.8	nd
Ah1	0-7	7.6	14.2	6.8	nd	.4	nd	1.3	.3	.3	95.7	.0	27.1	nd
IIAh2	7-24	7.7	12.5	4.5	nd	.2	nd	.5	.3	.0	97.9	.0	20.6	nd
IIBm	24-45	7.7	.8	.9	nd	.1	nd	.5	.0	.0	94.6	.0	17.0	nd
IIBC	45-58	7.9	13.3	3.3	nd	.1	nd	nd	.0	.0	93.4	5.5	17.1	nd
IIC	58-76	8.0	27.7	nd	nd	nd	nd	nd	.0	.0	99.2	.0	14.5	nd
IIIC	76-100+	8.2	38.2	nd	nd	nd	nd	nd	.3	.0	99.4	.0	12.1	nd

Horizon	Depth	Mechanical Analysis					Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis					Free R_2O_3 (Oxalate)		
		G	S	Si	C	FC				Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	2-0	nd	nd	nd	nd	nd	nd	nd	nd	370.1	181.2	141.0	40.2	11.5	nd	nd	nd
Ah1	0-7	1	21	48	31	13	nd	nd	nd	62.5	30.5	20.5	10.0	3.7	nd	nd	nd
IIAh2	7-24	2	29	39	32	16	nd	nd	nd	41.8	23.5	12.9	10.6	3.0	nd	nd	nd
IIBm	24-45	2	36	33	31	16	nd	nd	nd	39.3	19.1	10.5	8.6	3.1	nd	nd	nd
IIBC	45-58	10	30	40	30	11	nd	nd	nd	37.4	19.7	11.3	8.4	3.3	nd	nd	nd
IICn	58-76	1	20	48	32	12	nd	nd	nd	37.7	24.8	11.6	13.2	2.4	nd	nd	nd
IIIC	76-100+	1	5	61	34	13	nd	nd	nd	35.8	26.3	9.4	16.9	2.3	nd	nd	nd

Sub-group: .... Orthic Gray Luvisol.

Profile number: .... S 12.

Location: .... Between Survey Plots #62 and #77.

Vegetation: Tree: .... Populus sp..

Shrub: .... Spiraea sp., Rosa sp..

Ground: .... Calamagrostis sp., Epilobium sp., Aster sp..

Parent material: .... Colluvium/Mixed Till I/Sandy Lacustrine.

Topography: .... Steeply sloping; aspect E.

Elevation: .... 4610 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	6 - 0	Organic material in various stages of decomposition.
Ae	0 - 14	Yellowish brown (10 YR 5/4) silt loam to loam, yellowish brown to pale brown (10 YR 5/4-6/3) when dry; weak, coarse platy; friable; pH 5.4; clear, wavy boundary.
IIAB	14 - 24	Pale brown (10 YR 6/3) loam, light yellowish brown (10 YR 6/4) when dry; strong, medium subangular blocky; firm; pH 5.3; moderately gravelly; clear, smooth boundary.
IIBt1	24 - 54	Yellowish brown (10 YR 5/4) clay loam, yellowish brown (10 YR 5/4) when dry;

Horizon	Depth (cm)	Description
IIBt1	24 - 54	strong, medium to coarse subangular blocky; firm; pH 5.2; very gravelly; clear, smooth boundary.
IIBt2	54 - 71	Grayish brown to brown (10 YR 5/2-4/3) clay loam to clay, grayish brown to light brownish gray (10 YR 5/2-6/2) when dry; strong, medium subangular blocky; firm; pH 5.6; very gravelly; abrupt, smooth boundary.
IIIC	71 - 100 +	Dark brown to brown (10 YR 4/3) sandy loam to sandy clay loam, grayish brown (10 YR 5/2) when dry; amorphous; friable; pH 6.4; slightly gravelly.

Sub-group: Orthic Gray Luvisol

Profile No. S12

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	6-0	6.3	nd	nd	27.6	1.54	nd	13.1	.2	2.6	84.1	.0	101.8	nd
Ae	0-14	5.4	nd	nd	1.0	.09	11.0	30.6	1.2	7.1	49.4	11.7	10.2	nd
IIAB	14-24	5.3	nd	nd	.6	.06	9.8	14.2	.8	5.0	72.5	7.5	14.4	nd
IIBt1	24-54	5.2	nd	nd	.9	.06	14.7	11.3	.5	4.3	74.8	9.1	23.8	nd
IIBt2	54-71	5.6	nd	nd	.7	.06	10.8	8.7	.0	3.8	74.3	13.2	22.5	nd
IIIC	71-100+	6.4	nd	nd	nd	nd	nd	7.8	.0	3.3	73.3	15.6	9.8	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	6-0	nd	nd	nd	nd	nd	nd	nd	nd	230.6	104.1	78.0	26.1	14.3	nd	nd	nd
Ae	0-14	2	33	50	17	5	nd	nd	nd	29.5	16.4	6.1	10.3	1.1	nd	nd	nd
IIAB	14-24	3	39	35	26	12	nd	nd	nd	28.2	16.7	8.9	7.8	1.9	nd	nd	nd
IIBt1	24-54	8	33	34	33	20	nd	nd	nd	34.7	22.4	13.6	8.8	3.7	nd	nd	nd
IIBt2	54-71	3	29	31	40	23	nd	nd	nd	33.6	22.2	13.2	9.0	3.9	nd	nd	nd
IIIC	71-100+	4	55	25	20	11	nd	nd	nd	23.5	9.5	5.0	4.5	1.8	nd	nd	nd

Sub-group: .... Cumulic Rego Black.

Profile number: .... S 13.

Location: .... Near Survey Plot #133.

Vegetation: Tree: ....

Shrub: .... *Rosa* sp., *Symphoricarpus* sp..

Ground: .... *Calamagrostis* sp., *Geranium* sp..

Parent material: .... Alluvium/Colluvium.

Topography: .... Steeply sloping; aspect E..

Elevation: .... 4510 ft. M.S.L..

Drainage: .... Moderately well.

Horizon	Depth (cm)	Description
L - F	3 - 0	Organic material in early stages of decomposition.
Ahej	0 - 14	Black (10 YR 2/1) clay loam, very dark gray (10 YR 3/1) when dry; strong, coarse prismatic breaking to fine, subangular blocky; friable; pH 6.7; slightly gravelly; clear, smooth boundary.
Ah2	14 - 50	Very dark grayish brown (10 YR 3/2) clay loam, dark gray (10 YR 4/1) when dry; strong, very coarse prismatic breaking to medium, subangular blocky; friable; pH 6.7; slight effervescence; slightly gravelly; gradual, smooth boundary.
Ah3	50 - 74	Very dark grayish brown to dark grayish

Horizon	Depth (cm)	Description
Ah3	50 - 74	brown (10 YR 3/2-4/2) clay loam, dark gray (10 YR 4/1) when dry; strong very coarse prismatic breaking to medium, subangular blocky; firm; pH 7.3; slight effervescence; slightly gravelly; clear, smooth boundary.
AC	74 - 82	Dark brown to dark grayish brown (10 YR 3/3-4/2) clay loam, dark gray to dark grayish brown (10 YR 4/1-4/2) when dry; strong, coarse prismatic breaking to fine, subangular blocky; firm; pH 7.7; slight effervescence; moderately gravelly; clear, smooth boundary.
IICca1	82 - 91	Dark brown to brown (10 YR 4/3) loam, pale brown (10 YR 6/3) when dry; pseudo subangular blocky to amorphous; friable; pH 7.8; strong effervescence; very gravelly; clear, smooth boundary.
IICca2	91 - 112	Grayish brown to brown (10 YR 5/2-5/3) loam, very pale brown (10 YR 7/3) when dry; pseudo subangular blocky to amorphous; friable; pH 7.9; strong effervescence; moderately channery; clear, smooth boundary.
IIC	112 - 120 +	Dark gray to grayish brown (10 YR 4/2-5/2) loam, light brownish gray (10 YR 6/2) when dry; amorphous; friable; pH 7.9; strong effervescence; slightly channery.

Sub-group: Cumulic Rego Black

Profile No. S13

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-F	3-0	7.1	1.2	nd	30.1	2.0	nd	5.3	.1	4.5	82.2	7.9	92.2	nd
Ahej	0-14	6.7	0.4	nd	7.9	.6	12.4	7.2	.3	5.1	84.0	3.4	42.4	nd
Ah2	14-50	6.7	0.2	nd	4.0	.5	8.0	4.9	.3	2.5	88.3	4.0	34.5	nd
Ah3	50-74	7.3	1.1	nd	2.8	.3	11.1	.7	.4	2.2	89.2	7.5	29.5	nd
AC	74-82	7.7	3.0	2.8	nd	.2	nd	nd	.3	1.5	98.2	.0	22.5	nd
IICca1	82-91	7.8	15.1	4.0	nd	.1	nd	nd	.3	1.0	98.7	.0	16.8	nd
IICca2	91-112	7.9	15.2	3.7	nd	.1	nd	nd	.8	1.3	97.9	.0	18.3	nd
IIC	112-120+	7.9	8.2	nd	nd	nd	nd	nd	.3	1.3	98.4	.0	15.3	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-F	3-0	nd	nd	nd	nd	nd	nd	nd	nd	229.7	111.3	89.7	21.6	9.5	nd	nd	nd
Ahej	0-14	0	26	44	30	9	.95	57.6	60	74.4	34.7	24.8	9.9	4.3	nd	nd	nd
Ah2	14-50	0	26	45	29	13	1.08	54.8	51	55.6	27.7	18.0	9.7	3.1	nd	nd	nd
Ah3	50-74	0	23	45	32	15	1.12	54.5	48	46.2	25.2	15.3	9.9	3.1	nd	nd	nd
AC	74-82	0	26	44	30	17	1.18	52.6	45	43.7	23.6	14.1	9.5	2.6	nd	nd	nd
IICca1	82-91	4	29	46	25	10	1.18	53.9	46	36.6	19.4	12.1	7.3	2.1	nd	nd	nd
IICca2	91-112	4	28	48	24	11	1.17	53.9	46	44.7	23.1	14.0	9.0	2.4	nd	nd	nd
IIC	112-120+	5	34	47	19	6	1.08	58.0	54	38.8	22.2	11.5	10.7	2.2	nd	nd	nd

Sub-group: .... Orthic Black.

Profile number: .... S 14.

Location: .... Near Survey Plot #132.

Vegetation: Tree: ....

Shrub: ....

Ground: .... *Danthonia* sp., *Festuca* sp., *Koeleria* sp., *Stipa* sp., *Lupinus* sp., *Oxytropus* sp., *Lithospermum* sp., *Geum* sp..

Parent material: .... Till.

Topography: .... Steeply sloping; aspect E..

Elevation: .... 4530 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - F	2 - 0	Organic material in early stages of decomposition.
Ah	0 - 8	Black (10 YR 2/1) clay loam, very dark gray (10 YR 3/1) when dry; strong, medium prismatic breaking to fine, subangular blocky; friable; pH 6.4; slightly angular gravelly; abrupt, irregular boundary.
Bt1	8 - 26	Dark grayish brown to brown (10 YR 4/2-4/3) clay, yellowish brown (10 YR 5/4) when dry; strong, medium prismatic breaking to strong; medium subangular blocky; firm; pH 5.8; slightly angular gravelly; gradual irregular boundary.

Horizon	Depth (cm)	Description
Bt2	26 - 57	Brown to dark brown (10 YR 4/3) clay loam, yellowish brown to light yellowish brown (10 YR 5/4-6/4) when dry; strong, medium subangular blocky; firm; pH 6.0; moderately angular gravelly; abrupt, smooth boundary.
Cca	57 - 100 +	Grayish brown to light brownish gray (10 YR 5/2-6/2) clay loam, light gray to very pale brown (10 YR 7/2-7/3) when dry; amorphous; firm; pH 7.8; strong effervescence; exceedingly gravelly.

Sub-group: Orthic Black

Profile No. S14.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-F	2-0	6.9	nd	nd	21.7	1.60	nd	7.1	.2	5.0	86.7	1.0	66.1	nd
Ah	0-8	6.4	nd	nd	8.0	.72	11	12.3	.3	5.3	78.2	3.9	43.6	nd
Bt1	8-26	5.8	nd	nd	1.7	.12	14	8.6	.4	4.5	75.9	10.6	31.7	nd
Bt2	26-57	6.0	nd	nd	1.9	.10	19	7.5	.5	3.5	77.9	10.6	24.3	nd
Cca	57-100+	7.8	13.8	2.4	nd	nd	nd	nd	nd	nd	nd	nd	17.4	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-F	2-0	nd	nd	nd	nd	nd	nd	nd	nd	156.1	75.0	59.2	15.8	6.9	nd	nd	nd
Ah	0-8	1	24	39	37	11	.89	59.4	66	74.6	38.0	28.2	9.8	5.0	nd	nd	nd
Bt1	8-26	0	22	30	48	28	1.08	56.8	53	39.9	25.8	17.3	8.5	3.6	nd	nd	nd
Bt2	26-57	2	28	36	36	18	1.06	58.6	55	36.8	27.6	13.7	13.9	3.2	nd	nd	nd
Cca	57-100+	2	33	37	30	7	1.40	45.5	32	33.1	19.3	10.7	8.6	2.8	nd	nd	nd

Sub-group: .... Orthic Gray Luvisol.

Profile number: .... S 15.

Location: .... Near Survey Plot #38.

Vegetation: Tree: .... Populus sp..

Shrub: .... Salix sp., Spiraea sp..

Ground: .... Calamagrostis sp., Aster sp., Geranium sp., Fragaria sp..

Parent material: .... Colluvium/Mixed Till 1/Till.

Topography: .... Very steeply sloping; aspect N.

Elevation: .... 4610 ft. M.S.L..

Drainage: .... Moderately well.

Horizon	Depth (cm)	Description
L - H	4 - 0	Organic material in various stages of decomposition.
Ae	0 - 10	Brown to dark brown (10 YR 4/3) loam, light brownish gray to pale brown (10 YR 6/2-6/2) when dry; weak, medium platy; friable; pH 6.2; slightly angular gravelly; abrupt, smooth boundary.
IIAB	10 - 20	Gray to light brownish gray (10 YR 5/1-6/2) clay loam, pale to very pale brown (10 YR 6/3-7/4) when dry; strong, fine subangular blocky; firm; pH 6.0; slightly angular cobbly; abrupt, smooth boundary.
IIBt1	20 - 42	Dark gray to dark grayish brown (10 YR 4/1-4/2) clay, light yellowish brown

Horizon	Depth (cm)	Description
IIBt1	20 - 42	(10 YR 6/4) when dry; strong, coarse subangular blocky breaking to strong, fine subangular blocky; very firm; pH 5.3; slightly angular cobbly; abrupt, smooth boundary.
IIBt2	42 - 47	Dark gray (10 YR 4/1) clay, grayish brown (10 YR 5/2) when dry; strong, coarse subangular blocky breaking to fine subangular blocky; very firm; pH 5.7; abrupt, wavy boundary.
IIBt3	47 - 74	Dark gray to dark grayish brown (10 YR 4/1-4/2) clay loam, light yellowish brown (10 YR 6/4) when dry; weak, coarse subangular blocky to amorphous; firm; pH 7.1; slight effervescence; moderately angular gravelly to angular cobbly; abrupt, smooth boundary.
IIIBC	74 - 96	Brown to yellowish brown (10 YR 4/3-5/4) silty clay loam, light yellowish brown (10 YR 6/4) when dry; weak, coarse subangular blocky to amorphous; firm; pH 7.1; slight effervescence; moderately angular gravelly to angular cobbly; abrupt, smooth boundary.
IIIC	96 - 120 +	Grayish brown to brown (10 YR 5/2-5/3) clay loam, pale to very pale brown (10 YR 6/3-7/3) when dry; amorphous; firm; pH 7.6; strong effervescence; moderately angular cobbly.

Sub-group: Orthic Gray Luvisol

Profile No. S15

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	4-0	6.8	nd	nd	34.1	1.64	nd	7.4	.2	3.4	84.3	4.7	121.5	nd
Ae	0-10	6.2	nd	nd	1.5	.13	11	17.1	.9	6.3	65.8	9.9	12.3	nd
IIAB	10-30	6.0	nd	nd	.9	.09	12	11.0	.7	5.5	73.1	9.7	17.6	nd
IIBt1	20-42	5.3	nd	nd	.9	.08	12	12.0	.5	3.5	75.0	9.0	25.7	nd
IIBt2	42-47	5.7	nd	nd	1.3	.07	18	6.9	.4	2.5	78.0	12.2	33.1	nd
IIBt3	47-74	5.9	nd	nd	.6	.07	10	8.3	.5	2.6	77.1	11.5	23.2	nd
IIIBC	74-96	7.1	5.7	nd	1.8	.06	nd	nd	.3	1.2	97.6	.9	22.2	nd
IIIC	96-120+	7.6	16.5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	4-0	nd	nd	nd	nd	nd	nd	nd	nd	262.0	137.0	104.0	33.0	11.8	nd	nd	nd
Ae	0-10	2	36	47	17	6	1.16	54.3	47	33.3	18.4	7.1	11.3	1.3	nd	nd	nd
IIAB	10-20	6	21	44	35	18	1.37	46.7	34	31.2	21.8	10.9	10.9	2.5	nd	nd	nd
IIBt1	20-42	1	20	34	46	24	1.47	42.1	29	35.9	23.9	14.5	9.4	3.6	nd	nd	nd
IIBt2	42-47	2	5	28	67	36	1.40	45.1	32	46.6	30.3	20.0	10.3	4.5	nd	nd	nd
IIBt3	47-74	0	31	33	36	19	1.53	41.2	27	35.0	20.4	12.5	7.9	3.2	nd	nd	nd
IIIBC	74-96	3	17	46	37	15	1.52	40.4	27	35.4	23.6	13.1	10.5	3.0	nd	nd	nd
IIIC	96-120+	11	28	43	29	8	1.64	36.9	24	30.2	20.9	10.3	10.6	1.0	nd	nd	nd

Sub-group: .... Degraded Eutric Brunisol (with Overlay).

Profile number: .... S 16.

Location: .... Between Survey Plots #130 and #147.

Vegetation: Tree: ....

Shrub: .... Arctostaphylos uvi-ursi.

Ground: .... Calamagrostis sp., Festuca scabrella, Lulpinus sp..

Parent material: .... Residual colluvium/Residual.

Topography: .... Strongly sloping; aspect NNE.

Elevation:...................... 5350 ft. M.S.L..

Drainage: .... Moderately well.

Horizon	Depth (cm)	Description
L - F	1 - 0	Organic material in various stages of decomposition.
Ahj	0 - 4	Grayish brown (10 YR 5/2) sandy loam, brown (10 YR 5/3) when dry; weak, medium platy; very friable; pH 5.9; slightly gravelly.
IIH	4 - 5	Humus; altered organic material.
IIAej	5 - 12	Brown to pale brown (10 YR 5/3-6/3) sandy loam, yellowish brown (10 YR 5/4) when dry; weak, medium platy; very friable; pH 5.8; slightly channery; abrupt, smooth boundary.
IIBmj	12 - 24	Yellowish brown (10 YR 5/4) sandy loam,

Horizon	Depth (cm)	Description
IIBmtj	12 - 24	light yellowish brown (10 YR 6/4) when dry; strong, medium subangular blocky; friable; pH 5.4; exceedingly channery to cobbly; abrupt, broken boundary.
Rock	24 +	Sandstone.

Sub-group: Degraded Eutric Brunisol with Overlay   Profile No. S16.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	1-0	5.7	nd	nd	39.2	1.2	nd	nd	nd	nd	nd	nd	nd	nd
Ahj	0-4	5.9	nd	nd	2.5	.2	13.8	26.7	.0	6.1	57.3	9.9	14.1	nd
IIH	4-5	5.8	nd	nd	nd	.7	nd	nd	nd	nd	nd	nd	nd	nd
IIAej	5-12	5.8	nd	nd	1.6	.1	16.8	24.7	.0	4.3	55.9	15.1	10.5	nd
IIBmtj	12-24	5.4	nd	nd	1.3	.1	15.5	27.1	.0	4.2	56.3	12.4	10.9	nd
Rock	24+	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	1-0	nd	nd	nd	nd	nd	nd	nd	nd	nd	18.4	5.5	12.9	6.2	nd	nd	nd
Ahj	0-4	5	65	21	14	8	nd	nd	nd	nd	16.6	11.2	5.4	1.3	.05	.06	.11
IIH	4-5	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	4.7	nd	nd	nd
IIAej	5-12	2	66	19	15	6	nd	nd	nd	nd	11.9	8.7	3.2	0.9	.06	.05	.11
IIBmtj	12-24	2	60	21	19	10	nd	nd	nd	27.8	13.9	8.5	5.4	1.2	.04	.07	.11
Rock	24+	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Sub-group: .... Dark Gray Luvisol.

Profile number: .... S 17.

Location: .... Between Survey Plots #89 and #90.

Vegetation: Tree: .... *Populus tremuloides*.

Shrub: .... *Amelanchier* sp., *Rosa* sp..

Ground: .... *Aster* sp., *Fragaria* sp., *Calamagrostis* sp..

Parent material: .... Colluvium/Mixed Till 1.

Topography: .... Steeply sloping; aspect NE.

Elevation: .... 4665 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	3 - 0	Organic material in various stages of decomposition.
Ahe	0 - 7	Black (10 YR 2/1) loam, very dark to dark gray (10 YR 3/1-4/1) when dry; weak, coarse prismatic breaking to strong, medium granular; friable; pH 6.0; slightly gravelly; abrupt, wavy boundary.
Ae	7 - 13	Very dark grayish brown (10 YR 3/2) loam, grayish to pale brown (10 YR 5/2-6/3) when dry; weak, coarse platy; friable; pH 5.8; moderately gravelly; clear, wavy boundary.
IIBt1	13 - 38	Dark brown to dark grayish brown (10 YR 3/3-4/2) clay loam, light yellowish brown (10 YR 6/4) when dry; strong, medium subangular blocky; firm; pH 5.4; moderately

Horizon	Depth (cm)	Description
IIBt1	13 - 38	gravelly; clear, smooth boundary.
IIBt2	38 - 66	Dark grayish brown to brown (10 YR 4/2-4/3) clay loam, pale brown (10 YR 6/3) when dry; strong, medium to coarse subangular blocky; firm; pH 4.9; slightly gravelly; clear, smooth boundary.
IIBC	66 - 86	Dark grayish brown to grayish brown (10 YR 4/2-5/2) clay loam, pale to very pale brown (10 YR 6/3-7/4) when dry; strong, coarse subangular blocky; firm; pH 5.2; very gravelly; clear, smooth boundary.
IIC	86 - 98 +	Dark brown to brown (10 YR 4/3) clay loam, light gray to very pale brown (10 YR 7/2-7/3) when dry; amorphous; firm; pH 6.2; moderately channery to gravelly.

Sub-group: Dark Gray Luvisol

Profile No. S17

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	3-0	6.7	nd	nd	36.4	2.1	nd	6.5	.1	3.6	85.1	4.7	104.8	nd
Ahe	0-7	6.0	nd	nd	8.1	.4	19.0	18.0	.0	6.9	70.2	4.9	28.7	nd
Ae	7-13	5.8	nd	nd	2.3	.2	13.9	16.7	.0	8.1	63.1	12.1	17.7	nd
IIBt1	13-38	5.4	nd	nd	1.7	.1	15.0	15.2	.0	4.8	68.5	11.5	21.4	nd
IIBt2	38-66	4.9	nd	nd	1.1	.1	14.7	15.6	.6	2.9	66.4	14.5	21.4	nd
IIBC	66-86	5.2	nd	nd	1.0	.1	15.2	14.9	.6	2.6	65.6	16.3	19.0	nd
IIC	86-96+	6.2	nd	nd	.7	.1	nd	5.7	.5	2.1	84.4	7.3	21.4	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	3-0	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	12.7	nd	nd	nd
Ahe	0-7	2	36	42	22	14	1.13	52.7	47	48.7	29.4	21.9	7.5	3.2	.08	.09	.17
Ae	7-13	10	32	41	27	14	1.11	56.1	50	36.5	21.5	12.4	9.1	2.0	.06	.09	.15
IIBt1	13-38	6	34	29	37	20	1.35	48.5	36	35.8	19.7	12.2	7.5	3.0	.05	.10	.15
IIBt2	38-66	2	35	27	38	21	1.55	38.7	25	29.6	18.2	11.8	6.4	3.0	.04	.09	.13
IIBC	66-86	4	37	30	33	17	1.46	43.8	29	32.1	16.6	11.0	5.6	2.4	.04	.07	.11
IIC	86-96+	3	31	33	36	18	1.60	38.0	24	34.7	23.0	12.2	10.8	2.9	.04	.03	.07

Sub-group: .... Degraded Dystric Brunisol.

Profile number: .... S 18.

Location: .... Near Survey Plot #100.

Vegetation: Tree: .... *Populus tremuloides*.

Shrub: .... *Salix* sp., *Betula* sp..

Ground: .... *Epilobium* sp., *Aster* sp..

Parent material: .... Residual Colluvium/Mixed Till II.

Topography: .... Strongly sloping; aspect NE.

Elevation: .... 5260 ft. M.S.L..

Drainage: .... Moderately well.

Horizon	Depth (cm)	Description
L - H	5 - 0	Organic material in various stages of decomposition.
Aej	0 - 10	Grayish brown (10 YR 5/2) sandy loam, light brownish gray to pale brown (10 YR 6/2-6/3) when dry; weak, coarse platy; very friable; pH 5.4; moderately angular gravelly; clear, wavy boundary.
Bm1	10 - 23	Brown (10 YR 4/3-5/3) loam to clay loam, brown to pale brown (10 YR 5/3-6/3) when dry; strong, medium subangular blocky; friable; pH 5.0; very angular gravelly; gradual, wavy boundary.
Bm2	23 - 52	Brown to dark brown (10 YR 4/3) loam to sandy clay loam, yellowish brown (10 YR 5/4) when dry; strong, medium subangular blocky; friable; pH 5.0; moderately to

Horizon	Depth (cm)	Description
Bm2	23 - 52	very angular gravelly; clear, smooth boundary.
IIBC	52 - 73	Dark grayish brown to brown (10 YR 4/2-4/3) clay loam, pale brown (10 YR 6/3) when dry; strong, medium subangular blocky; firm; pH 5.1; very cobbly to channery; abrupt, smooth boundary.
IIC	73 - 85 +	Dark gray (10 YR 4/1) silty clay loam, gray to grayish brown (10 YR 6/2-5/2) when dry; amorphous; firm; pH 7.1; slight effervescence; moderately angular gravelly to channery.

Sub-group: Degraded Dystric Brunisol

Profile No. S18

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	5-0	6.1	nd	nd	34.8	2.04	nd	13.5	.1	4.9	79.8	1.7	113.8	nd
Aej	0-10	5.4	nd	nd	1.9	.12	16.0	38.9	.0	8.4	49.5	3.2	11.1	99.9
Bm1	10-23	5.0	nd	nd	.9	.07	12.8	28.0	.0	4.0	59.0	9.0	11.9	98.8
Bm2	23-52	5.0	nd	nd	.9	.05	16.5	23.9	.0	2.8	65.1	8.3	14.0	97.2
IIBC	52-73	5.1	nd	nd	1.0	.07	14.6	17.4	.0	2.1	71.5	9.0	18.8	99.4
IIC	73-85+	7.1	5.2	nd	nd	nd	nd	nd	.3	.9	94.7	4.1	22.8	nd

Horizon	Depth	Mechanical Analysis C	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	5-0	nd	nd	nd	nd	nd	nd	nd	nd	320.5	138.5	113.9	24.6	12.0	nd	nd	nd
Aej	0-10	6	57	28	15	7	1.18	54.1	46	28.7	14.6	7.2	6.7	1.2	.06	.06	.12
Bm1	10-23	3	53	29	18	10	1.23	52.9	43	28.5	14.0	7.9	6.1	1.6	.04	.06	.10
Bm2	23-52	3	50	28	22	12	1.40	44.7	31	24.6	15.9	9.1	6.8	2.5	.04	.06	.10
IIBC	52-73	1	34	38	28	14	1.37	46.5	34	30.7	20.3	11.9	8.4	3.5	.05	.07	.12
IIC	73-85+	3	17	47	36	13	1.39	44.0	32	36.3	26.3	14.2	12.1	4.5	.05	.05	.10

Sub-group: .... Montane Orthic Black.

Profile number: .... S 19.

Location: .... Near Survey Plot #86.

Vegetation: Tree: ....

Shrub: .... *Potentilla fruticosa*.

Ground: .... *Festuca* sp., *Danthonia* sp., *Poa* sp., *Koeleria* sp., *Anemone* sp., *Geum* sp., *Heuchera* sp., *Antennaria* sp..

Parent material: .... Residual/Rock.

Topography: .... Moderately sloping; aspect NE.

Elevation: .... 5255 ft. M.S.L..

Drainage: .... Moderately well.

Horizon	Depth (cm)	Description
L - F	2 - 0	Organic material in early stages of decomposition.
Ah	0 - 17	Black (10 YR 2/1) loam, very dark grayish brown (10 YR 3/2) when dry; strong, medium prismatic breaking to strong, coarse angular; very friable; pH 5.9; slightly gravelly; clear, wavy boundary.
Btj	17 - 36	Dark brown to brown (10 YR 3/3-4/3) loam, yellowish brown (10 YR 5/4) when dry; weak, medium prismatic breaking to strong, fine subangular blocky; friable; pH 5.5; slightly gravelly; clear, smooth boundary.

Horizon	Depth (cm)	Description
C	36 - 55	Brown to grayish brown (10 YR 4/3-5/2) loam, grayish brown to brown (10 YR 5/3) when dry; weak, medium granular to amorphous; very friable; pH 5.7; very channery; abrupt, broken boundary.
Rock	55 +	Sandstone.

Sub-group: Montane Orthic Black   Profile No. S19.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-F	2-0	6.2	nd	nd	20.0	1.25	nd	14.8	.2	4.0	76.4	4.6	55.8	nd
Ah	0-17	5.9	nd	nd	5.5	.53	10	29.0	.0	2.8	65.0	3.2	25.7	nd
Btj	17-36	5.5	nd	nd	1.9	.13	14	28.1	.0	2.2	68.1	1.6	15.6	nd
C	36-55	5.7	nd	nd	1.5	nd	nd	30.5	.0	2.1	58.9	8.5	11.7	nd
Rock	55+	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-F	2-0	nd	nd	nd	nd	nd	nd	nd	nd	192.3	69.4	55.2	14.2	6.0	nd	nd	nd
Ah	0-17	1	49	34	17	9	.98	58.5	60	70.4	25.5	19.4	6.1	2.7	.08	.09	.17
Btj	17-36	1	40	37	23	11	1.17	53.9	46	29.9	17.8	9.3	8.5	2.2	.06	.10	.16
C	36-55	13	48	34	18	8	1.26	51.0	40	34.4	17.1	8.1	9.0	2.0	.05	.05	.10
Rock	55+	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Sub-group: .... Montane Eluviated Black.

Profile number: .... S 20.

Location: .... Near Survey Plot #85.

Vegetation: Tree: .... Populus tremuloides.

Shrub: .... Rosa sp., Spiraea sp..

Ground: .... Calamagrostis sp., Epilobium sp..

Parent material: .... Residual colluvium/Rock.

Topography: .... Very steeply sloping; aspect NNE.

Elevation: .... 5230 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	4 - 0	Organic material in various stages of decomposition.
Ah	0 - 9	Black (10 YR 2/1) sandy loam to loam, very dark grayish brown (10 YR 3/2) when dry; strong, medium prismatic; very friable; pH 5.9; abrupt, irregular boundary.
Aej	9 - 13	Dark grayish brown to brown (10 YR 4/2-4/3) sandy loam, pale brown (10 YR 6/3) when dry; weak, coarse platy; very friable; pH 5.8; abrupt, irregular boundary.
Bm	13 - 37	Brown to dark brown (10 YR 4/3) sandy loam, yellowish brown (10 YR 5/4) when dry; weak, fine subangular blocky; very friable; pH 5.7; very to exceedingly channery; abrupt, broken boundary.
Rock	37 +	Sandstone.

Sub-group: Montane Eluviated Black　　Profile No. S20

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	4-0	5.7	nd	nd	12.6	1.20	nd	21.9	.7	4.0	70.4	3.0	68.3	nd
Ah	0-9	5.9	nd	nd	3.4	.28	11.9	26.1	.5	3.2	67.6	2.6	19.4	nd
Aej	9-13	5.8	nd	nd	1.1	.09	13.1	28.6	1.1	2.2	61.5	6.6	9.9	nd
Bm	13-37	5.7	nd	nd	1.1	.08	13.6	26.0	1.0	2.1	61.5	9.4	10.8	nd
Rock	37+													

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	4-0	nd	nd	nd	nd	nd	nd	nd	nd	325.3	90.1	77.7	12.4	8.5	nd	nd	nd
Ah	0-9	1	51	30	19	8	.95	60.7	64	50.1	19.9	12.2	7.7	2.9	.10	.08	.18
Aej	9-13	1	55	29	16	6	nd	nd	nd	30.7	12.9	6.1	6.8	1.2	.07	.06	.13
Bm	13-37	2	55	27	18	7	1.18	54.1	46	29.4	14.1	7.4	6.7	2.0	.07	.07	.14
Rock	37+																

Sub-group: .... Cumulic Rego Dark Gray.

Profile number: .... S 21.

Location: .... Near Survey Plot #70.

Vegetation: Tree: .... *Populus* sp..

Shrub: .... *Spiraea* sp..

Ground: .... *Heracleum* sp., *Aster* sp., *Calamagrostis* sp..

Parent material: .... Residual colluvium/Residual/Rock.

Topography: .... Very steeply sloping; aspect NNE.

Elevation: .... 5230 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	4 - 0	Organic material in various stages of decomposition.
Ah1	0 - 28	Dark gray to very dark grayish brown (10 YR 4/1-3/2) sandy loam, dark gray to dark grayish brown (10 YR 4/1-4/2) when dry; strong, medium granular; very friable; pH 6.2.
Ah2	28 - 56	Very dark grayish brown (10 YR 3/2) sandy loam, dark gray (10 YR 4/1) when dry; strong, medium granular; very friable; pH 6.2.
Ah3	56 - 84	Very dark grayish brown to dark brown (10 YR 3/2-3/3) sandy loam, dark gray to dark grayish brown (10 YR 4/1-4/2) when dry; strong, medium granular; very friable; pH 5.8.

Horizon	Depth (cm)	Description
Ah4	84 - 105	Very dark grayish brown to dark brown (10 YR 3/2-3/3) sandy loam, dark gray to dark grayish brown (10 YR 4/2-4/2) when dry; strong, medium granular; very friable; pH 5.5; abrupt, smooth boundary.
IIC	105 - 118	Yellowish brown to light yellowish brown (10 YR 5/4-6/4) sandy loam, very pale brown (10 YR 7/3) when dry; single grained; friable; pH 5.3; exceedingly channery; abrupt, broken boundary.
Rock	118 +	Sandstone.

Sub-group: Cumulic Rego Dark Gray

Profile No. S21

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	4-0	6.9	nd	nd	18.3	1.4	nd	5.1	.3	3.2	91.4	.0	80.8	nd
Ah1	0-28	6.2	nd	nd	2.5	.2	11.9	24.3	.7	2.8	68.7	3.5	15.1	nd
Ah2	28-56	6.0	nd	nd	1.9	.2	11.9	29.2	.7	1.5	66.4	2.2	13.2	nd
Ah3	56-84	5.8	nd	nd	1.3	.1	13.0	29.0	1.0	2.0	61.0	7.0	11.5	nd
Ah4	84-105	5.5	nd	nd	1.0	.1	11.1	39.3	1.1	1.1	55.1	3.4	10.9	nd
IIC	105-118	5.3	nd	nd	nd	nd	nd	29.6	1.4	1.4	59.2	8.4	7.3	nd
Rock	118+													

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	4-0	nd	nd	nd	nd	nd	nd	nd	nd	190.7	122.0	89.8	32.2	19.4	nd	nd	nd
Ah1	0-28	0	58	29	13	6	1.12	52.9	47	31.4	15.0	9.0	6.0	3.6	nd	nd	nd
Ah2	28-56	0	59	27	14	6	1.12	54.1	48	26.6	14.8	7.7	7.1	4.1	nd	nd	nd
Ah3	56-84	0	59	27	14	5	1.22	49.8	41	23.3	12.8	6.1	6.7	3.9	nd	nd	nd
Ah4	84-105	0	57	30	13	5	1.23	51.4	41	20.3	14.2	5.9	8.3	3.4	nd	nd	nd
IIC	105-118	16	60	30	10	5	1.27	51.0	40	19.1	13.0	4.3	8.7	1.3	nd	nd	nd
Rock	118+																

Sub-group: .... Dark Gray Luvisol.

Profile number: .... S 22.

Location: .... Near Survey Plot #71.

Vegetation: Tree: ....

Shrub: .... _Salix_ sp., _Betula_ sp., _Spiraea_ sp..

Ground: .... _Calamagrostis_ sp., _Carex_ sp., _Aster_ sp..

Parent material: .... Residual colluvium/Mixed Till II/ Disintegrated shale.

Topography: .... Steeply sloping; aspect NNE.

Elevation: .... 5240 ft. M.S.L.

Drainage: .... Moderately well.

Horizon	Depth (cm)	Description
L - H	8 - 0	Organic material in various stages of decomposition.
Ah	0 - 16	Very dark grayish brown (10 YR 3/2) loam, grayish brown (10 YR 5/2) when dry; strong, medium prismatic; friable; pH 6.3; abrupt, smooth boundary.
Ae	16 - 27	Brown to yellowish brown (10 YR 4/3-5/4) silt loam, light yellowish brown to very pale brown (10 YR 6/4-7/3) when dry; strong, medium platy; very friable; pH 6.0; clear, smooth boundary.
IIBt1	27 - 54	Dark grayish brown to brown (10 YR 4/2-4/3) silty clay loam, pale brown (10 YR 6/3) when dry; strong, medium subangular

Horizon	Depth (cm)	Description
IIBt1	27 - 54	blocky; very firm; pH 5.6; slightly to moderately angular gravelly; clear, smooth boundary.
IIBt2	54 - 77	Dark gray and yellowish brown (10 YR 4/1-5/4) silty clay, brown to pale brown (10 YR 5/3-6/3) when dry; strong, medium subangular blocky; very firm; pH 5.9; slightly to moderately angular gravelly; clear, smooth bounday.
IIIBCg	77 - 109	Gray (10 YR 5/1) silty clay, gray to light gray (10 YR 6/1) when dry; strong, fine subangular blocky; firm; pH 7.7; strong effervescence; moderately shaly; clear, smooth boundary.
IIICg	109 - 114 +	Gray (5 Y 5/1) silty clay, gray to light gray (10 YR 6/1) when dry; pseudo-platy to amorphous; firm; pH 7.8; strong effervescence; moderately shaly.

Sub-group: Dark Gray Luvisol

Profile No. S22

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	8-0	6.4	nd	nd	27.9	1.52	nd	7.4	.3	2.6	84.4	5.3	90.4	nd
Ah	0-16	6.3	nd	nd	3.0	.24	nd	13.3	1.2	6.0	79.5	.0	20.1	nd
Ae	16-27	6.0	nd	nd	.7	.07	nd	18.2	1.1	2.3	77.3	1.1	10.2	nd
IIBt1	27-54	5.6	nd	nd	.6	.06	nd	9.9	.5	1.6	80.2	7.8	21.6	nd
IIBt2	54-77	5.9	nd	nd	.8	.07	nd	7.5	.5	1.9	79.3	10.8	23.4	nd
IIIBCg	77-109	7.7	16.8	2.9	nd	.06	nd	nd	.0	.5	99.5	.0	19.3	nd
IIICg	109-114+	7.8	22.8	nd	nd	nd	nd	nd	.0	.5	99.5	.0	18.0	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	8-0	nd	nd	nd	nd	nd	nd	nd	nd	223.8	104.2	83.9	20.3	14.7	.04	.00	.04
Ah	0-16	0	27	51	22	6	1.09	55.7	51	38.9	23.8	12.8	11.0	3.9	.08	.06	.14
Ae	16-27	0	24	57	19	7	1.15	55.9	49	26.2	17.9	7.3	10.5	1.7	.05	.04	.09
IIBt1	27-54	3	12	49	39	23	1.44	43.3	30	33.8	23.1	14.1	9.0	3.8	.05	.01	.06
IIBt2	54-77	1	4	53	43	22	1.44	44.6	30	35.1	27.4	15.6	11.8	3.7	.05	.05	.10
IIIBCg	77-109	10	1	47	52	17	1.51	41.5	27	31.6	21.2	12.5	8.7	3.4	.03	.00	.03
IIICg	109-114+	2	1	53	46	17	1.56	20.0	25	33.2	22.9	11.2	11.7	3.0	.04	.03	.07

Sub-group: .... (Eroded) Carbonated Black.

Profile number: .... S 23.

Location: .... Ten chains East of Survey Plot #3.

Vegetation: Tree: ....

Shrub: .... _Potentilla fruticosa_, _Rosa_ sp..

Ground: .... _Danthonia_ sp., _Festuca_ sp., _Anemone_ sp., _Antennaria_ sp..

Parent material: .... Colluvium/Till.

Topography: .... Moderately sloping; aspect SW.

Elevation: .... 4900 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - F	1 - 0	Organic material in early stages of decomposition.
Ahk	0 - 3	Black to very dark gray (10 YR 2/1-3/1) clay loam, dark gray to very dark grayish brown (10 YR 4/1-3/2) when dry; strong, fine granular; friable; pH 7.5; slight effervescence; moderately angular gravelly; abrupt, smooth boundary.
IIBmk	3 - 18	Brown to dark brown (10 YR 4/3) loam, light yellowish brown (10 YR 6/4) when dry; strong, medium subangular blocky; friable; pH 7.4; very angular gravelly; abrupt, smooth boundary.

Horizon	Depth (cm)	Description
IICca	18 - 49	Pale brown (10 YR 6/3) loam, light gray to very pale brown (10 YR 7/2-7/3) when dry; amorphous; friable; pH 7.9; strong effervescence; exceedingly angular gravelly to cobbly; abrupt, smooth boundary.
IIC1	49 - 82	Grayish brown to brown (10 YR 5/2-5/3) loam, light gray to very pale brown (10 YR 7/2-7/3) when dry; amorphous; friable; pH 7.9; strong effervescence; moderately angular gravelly; abrupt, smooth boundary.
IIC2	82 - 90	Grayish brown (10 YR 5/2) silt loam, light gray to very pale brown (10 YR 7/2-7/3) when dry; amorphous; friable; pH 8.0; strong effervescence; moderately angular gravelly to channery; abrupt, smooth boundary.
IIC3	90 - 95 +	Light brownish gray to grayish brown (10 YR 6/2-5/2) silty clay loam to clay loam, light gray to very pale brown (10 YR 7/2-7/3) when dry; amorphous; friable; pH 8.1; moderately angular gravelly to channery.

Sub-group: Eroded Carbonated Black Profile No. S23.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis						pH-depend. C.E.C.
								exch. acid.	Na	K	Ca	Mg	TEC	
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-F	1-0	7.9	4.2	2.3	nd	.50	nd	1.5	.0	2.8	95.7	.0	31.6	nd
Ahk	0-3	7.5	1.8	4.7	nd	.30	15.7	1.0	.3	2.2	96.5	.0	24.9	nd
IIBmk	3-18	7.4	.0	2.6	nd	.11	23.6	1.2	.0	3.0	95.2	.0	16.5	nd
IICca	18-49	7.9	26.3	nd	nd	nd	nd	nd	1.6	.6	97.8	.0	6.8	nd
IIC1	49-82	7.9	21.4	nd	nd	nd	nd	nd	.0	.6	99.4	.0	11.4	nd
IIC2	82-90	8.0	24.8	nd	nd	nd	nd	nd	.0	.6	99.4	.0	11.4	nd
IIC3	90-95+	8.1	28.2	nd	nd	nd	nd	nd	.0	.3	99.7	.0	10.7	nd

Horizon	Depth	Mechanical Analysis					Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis					Free R_2O_3 (Oxalate)		
		G	S	Si	C	FC				Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-F	1-0	nd	nd	nd	nd	nd	nd	nd	nd	63.6	31.3	18.1	13.2	2.7	nd	nd	nd
Ahk	0-3	1	38	33	29	15	nd	nd	nd	46.2	23.8	12.6	11.2	2.4	nd	nd	nd
IIBmk	3-18	7	35	39	26	14	1.14	55.8	49	33.7	19.2	13.4	5.8	1.9	nd	nd	nd
IICca	18-49	24	35	41	24	10	1.18	55.6	47	24.6	17.4	8.1	9.3	0.8	nd	nd	nd
IIC1	49-82	1	29	47	24	10	1.37	47.9	35	27.8	14.3	7.3	7.0	1.4	nd	nd	nd
IIC2	82-90	8	22	51	27	10	1.48	43.7	30	30.6	17.8	8.4	9.4	1.4	nd	nd	nd
IIC3	90-95+	7	20	46	34	14	1.59	39.3	25	27.2	20.5	9.0	11.5	1.7	nd	nd	nd

Sub-group: .... Orthic Black.

Profile number: .... S 24.

Location:....................... 5 chains off East rim road on bench opposite cabin.

Vegetation: Tree: ....

Shrub: ....

Ground: .... <u>Danthonia</u> sp., <u>Festuca</u> sp., <u>Koeleria</u> sp., <u>Lupinus</u> sp., <u>Geum</u> sp., <u>Heuchera</u> sp..

Parent material: .... Colluvium/Till.

Topography: .... Strongly sloping; aspect W.

Elevation: .... 4840 ft. M.S.L..

Drainage: ....Well.

Horizon	Depth (cm)	Description
L - F	2 - 0	Organic material in early stages of decomposition.
Ah	0 - 12	Black to very dark brown (10 YR 2/1-2/2) clay loam, very dark gray (10 YR 3/1) when dry; strong, medium to coarse prismatic; friable; pH 6.6; moderately angular gravelly; abrupt, smooth boundary.
Bm	12 - 29	Dark brown (10 YR 3/3) clay loam, brown to yellowish brown (10 YR 4/3-5/4) when dry; strong, fine to medium subangular blocky; firm; pH 6.5; moderately to very angular gravelly; clear, smooth boundary.

Horizon	Depth (cm)	Description
IIBC	29 - 45	Grayish brown to brown (10 YR 5/2-5/3) silty clay loam, light brownish gray to pale brown (10 YR 6/2-6/3) when dry; strong, fine subangular blocky; firm; pH 7.5; strong effervescence; moderately angular gravelly; abrupt, smooth boundary.
IICca	45 - 69	Light yellowish brown (10 YR 6/4) silty clay loam, light gray to very pale brown (10 YR 7/2-7/3) when dry; amorphous; firm; pH 7.9; strong effervescence; very angular gravelly to angular cobbly; abrupt, smooth boundary.
IIC	69 - 83 +	Pale brown (10 YR 6/3) silty clay loam, very pale brown (10 YR 7/3) when dry; amorphous; firm; pH 8.0; strong effervescence; moderately to very subangular gravelly.

Sub-group: Orthic Black

Profile No. S24

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-F	2-0	7.0	1.0	nd	17.4	1.4	nd	3.9	.7	4.7	90.7	.0	59.3	nd
Ah	0-12	6.6	.2	nd	6.0	.5	12	8.1	.4	4.2	87.3	.0	28.7	nd
Bm	12-29	6.5	1.3	nd	2.6	.2	13	7.3	.6	3.9	83.8	4.4	20.4	nd
IIBC	29-45	7.5	13.0	2.9	nd	.1	nd	nd	.0	1.5	98.5	.0	16.8	nd
IICca	45-69	7.9	27.6	nd	nd	nd	nd	nd	.0	.8	99.2	.0	12.8	nd
IIC	69-83+	8.0	24.0	nd	nd	nd	nd	nd	.0	.9	99.1	.0	12.8	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-F	2-0	nd	nd	nd	nd	nd	nd	nd	nd	162.3	75.9	59.4	16.5	5.1	nd	nd	nd
Ah	0-12	2	29	37	34	18	.97	58.7	60	58.7	30.3	21.2	9.1	3.0	nd	nd	nd
Bm	12-29	2	25	41	34	18	1.05	58.2	55	32.7	22.6	14.0	8.6	2.3	nd	nd	nd
IIBC	29-45	6	13	48	39	17	1.34	47.9	36	33.6	19.8	11.5	8.3	2.1	nd	nd	nd
IICca	45-69	7	11	51	33	15	1.40	46.6	33	36.5	25.7	12.9	12.8	1.7	nd	nd	nd
IIC	69-83+	3	17	49	34	14	1.53	41.8	27	28.2	19.7	9.9	9.8	2.3	nd	nd	nd

Sub-group: .... (Eroded) Carbonated Black.

Profile number:.................. S 25.

Location: .... Near Survey Plot #13.

Vegetation: Tree: ....

Shrub: .... Potentilla fruticosa, Rosa sp., Festuca sp., Agropyron sp., Koeleria sp., Lupinus sp., Agoserus sp..

Parent material: .... Residual/Rock.

Topography: .... Moderately sloping; aspect SW.

Elevation: .... 4860 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - F	3 - 0	Organic material in early stages of decomposition.
Ahk	0 - 5	Black (10 YR 2/1) clay loam, dark grayish brown (10 YR 4/2) when dry; strong, fine prismatic; friable; pH 7.4; slight effervescence; moderately angular gravelly; abrupt, smooth boundary.
Bmk	5 - 7	Dark brown (10 YR 3/3) silty clay loam, yellowish brown (10 YR 5/4) when dry; strong, medium subangular blocky; friable; pH 7.6; slight effervescence; moderately channery to gravelly; abrupt, broken boundary.

Horizon	Depth (cm)	Description
C	7 - 42	Yellowish brown (10 YR 5/4) silty clay loam, light brownish gray to pale brown (10 YR 6/2-6/3) when dry; amorphous; friable; pH 7.9; strong effervescence; very channery to gravelly; abrupt, broken boundary.
Rock	42 +	

Sub-group: Eroded Carbonated Black

Profile No. S25.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Exchange Analysis: Na	Exchange Analysis: K	Exchange Analysis: Ca	Exchange Analysis: Mg	Exchange Analysis: TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-F	3-0	7.5	5.0	nd	8.92	.69	nd	1.3	.6	4.4	93.7	.0	37.8	nd
Ahk	0-5	7.4	2.9	nd	7.9	.52	nd	1.0	.2	2.6	96.2	.0	29.5	nd
Bmk	5-7	7.6	1.5	3.1	nd	.23	nd	nd	.4	3.5	96.1	.0	23.0	nd
C	7-42	7.9	26.9	0.0	nd	nd	nd	nd	nd	nd	nd	nd	13.5	nd
Rock	42+	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Horizon	Depth	Mechanical Analysis: G	Mechanical Analysis: S	Mechanical Analysis: Si	Mechanical Analysis: C	Mechanical Analysis: FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	Moisture Analysis: 1/3 bars	Moisture Analysis: 15 bars	Moisture Analysis: Avail. Moist.	Moisture Analysis: Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Free R_2O_3 (Oxalate): Al	Free R_2O_3 (Oxalate): Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-F	3-0	nd	nd	nd	nd	nd	nd	nd	nd	82.2	35.4	24.9	10.5	3.7	nd	nd	nd
Ahk	0-5	0	21	45	34	15	.94	59.5	63	61.8	32.5	19.4	13.1	3.1	nd	nd	nd
Bmk	5-7	1	19	47	34	10	nd	nd	nd	48.4	24.7	15.0	9.7	2.1	nd	nd	nd
C	7-42	3	10	56	34	12	1.09	58.2	54	38.2	24.2	10.3	13.9	1.5	nd	nd	nd
Rock	42+	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Sub-group: .... Cumulic Rego Black.

Profile number: .... S 26.

Location: .... Near Survey Plot #34.

Vegetation: Tree: ....

Shrub: .... <u>Rosa</u> sp..

Ground: .... <u>Phleum</u> sp., <u>Stipa</u> sp., <u>Geranium</u> sp..

Parent material: .... Alluvium/Alluvium.

Topography: .... Gently sloping; aspect NNE.

Elevation: .... 4460 ft. M.S.L..

Drainage: .... Moderately well.

Horizon	Depth (cm)	Description
L - F	1 - 0	Organic material in early stages of decomposition.
Ah1	0 - 14	Black (10 YR 2/1) loam, very dark gray (10 YR 3/1) when dry; weak, coarse prismatic breaking to strong, fine granular; friable; pH 6.8; clear, wavy boundary.
Ah2	14 - 52	Black (10 YR 2/1) loam, very dark gray to very dark grayish brown (10 YR 3/1-3/2) when dry; strong, coarse prismatic; friable; pH 6.5; abrupt, smooth boundary.
C	52 - 62	Very dark grayish brown (10 YR 3/2) sandy loam, dark grayish brown (10 YR 4/2) when dry; single grained to pseudo granular; friable; pH 6.4; moderately cobbly to exceedingly gravelly; clear, smooth boundary.

Horizon	Depth (cm)	Description
IIAh1b	62 - 80	Very dark gray to dark gray (10 YR 3/1-4/1) loam, brown to dark brown (10 YR 4/3) when dry; weak, coarse prismatic; very friable; pH 6.4; clear, smooth boundary.
IIAh2b	80 - 104	Very dark grayish brown (10 YR 3/2) loam, dark grayish brown (10 YR 4/2) when dry; weak, coarse prismatic; friable; pH 6.8; abrupt, smooth boundary.
IICca	104 - 124	Dark gray to dark grayish brown (10 YR 4/1-4/2) loam, white and grayish brown (10 YR 8/1-5/2) when dry; amorphous; friable; pH 7.9; strong effervescence; abrupt, smooth boundary.
IIC1	124 - 141	Dark gray (10 YR 4/1) loam, grayish brown (10 YR 5/2) when dry; amorphous; friable; pH 8.1; slight effervescence.
IIC2	141 - 144	Very dark gray to dark gray (10 YR 3/1-4/1) loam, dark gray (10 YR 4/1) when dry; friable; pH 8.0; strong effervescence.

Sub-group: Cumulic Rego Black

Profile No. S26

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-F	1-0	6.8	nd	nd	7.3	.85	nd	nd	nd	nd	nd	nd	nd	nd
Ah1	0-14	6.5	nd	nd	6.8	.53	12.8	6.8	.3	3.8	87.0	2.1	34.0	nd
Ah2	14-52	6.5	nd	nd	5.1	.34	15.0	8.3	.4	2.6	88.7	.0	26.1	nd
C	52-62	6.4	nd	nd	2.3	.06	nd	11.7	1.0	2.0	85.3	.0	10.9	nd
IIAh1b	62-80	6.4	nd	nd	1.7	.14	12.1	9.1	.6	2.0	87.0	1.3	17.2	nd
IIAh2b	80-104	6.8	nd	nd	2.1	.17	12.4	4.6	.0	1.6	93.8	.0	20.0	nd
IICca	104-124	7.9	7.2	nd	nd	nd	nd	nd	.2	.8	99.0	.0	16.5	nd
IIC1	124-141	8.1	7.6	nd	nd	nd	nd	nd	.2	.7	89.1	10.1	15.2	nd
IIC2	141-146+	8.0	6.4	nd	nd	nd	nd	nd	.3	.8	98.9	.0	15.7	nd

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-F	1-0	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	2.6	nd	nd	nd
Ah1	0-14	1	43	32	25	12	.90	60.7	67	63.1	30.0	20.2	9.8	3.4	nd	nd	nd
Ah2	14-52	1	44	31	25	12	1.04	57.0	55	50.9	31.8	13.2	18.6	2.6	nd	nd	nd
C	52-62	12	55	28	17	7	.86	66.3	77	25.4	12.2	4.3	7.9	.8	nd	nd	nd
IIAh1b	62-80	3	47	31	22	9	1.25	51.6	41	33.2	16.2	8.4	7.8	1.8	nd	nd	nd
IIAh2b	80-104	0	39	38	23	9	1.16	54.7	47	38.3	19.3	9.7	9.6	1.7	nd	nd	nd
IICca	104-124	0	38	40	22	9	1.19	53.3	45	251.6	23.2	11.3	11.9	2.5	nd	nd	nd
IIC1	124-141	0	41	39	20	10	1.29	49.0	37	34.5	18.9	10.6	8.3	3.2	nd	nd	nd
IIC2	141-146+	1	41	37	22	11	1.25	51.0	11	35.7	18.3	10.7	7.6	2.4	nd	nd	nd

Sub-group: .... Orthic Gray Luvisol.

Profile number: .... S 27.

Location: .... Between Survey Plots #118 and #119.

Vegetation: Tree: .... *Populus tremuloides*.

Shrub: .... *Salix* sp..

Ground: .... *Calamagrostis* sp., *Aster* sp., *Epilobium* sp..

Parent material: .... Colluvium/Mixed Till 1/Till.

Topography: .... Steeply sloping; aspect NW.

Elevation: .... 4460 ft. M.S.L..

Drainage: .... Moderately well.

Horizon	Depth (cm)	Description
L - H	4 - 0	Organic material in various stages of decomposition.
Ae1	0 - 4	Brown to dark brown (10 YR 4/3) loam, grayish brown (10 YR 5/2) when dry; strong, medium platy; very friable; pH 5.6; abrupt, smooth boundary.
Ae2	4 - 19	Dark brown (10 YR 3/3) loam, dark grayish brown to brown (10 YR 4/2-4/3) when dry; strong, coarse platy; friable; pH 6.0; clear, smooth boundary.
IIAB	19 - 26	Dark yellowish brown (10 YR 4/4) clay loam to silty clay loam, yellowish brown (10 YR 5/4) when dry; strong, fine subangular blocky; firm; pH 5.8; slightly to moderately angular gravelly; abrupt, wavy boundary.

Horizon	Depth (cm)	Description
IIBt	26 - 52	Dark yellowish brown to yellowish brown (10 YR 4/4-5/6) clay loam, yellowish brown to light yellowish brown (10 YR 5/4-6/4) when dry; weak, coarse subangular blocky breaking to strong, fine subangular blocky; firm; pH 6.3; very channery; abrupt, smooth boundary.
IIIBC	52 - 75	Brown to grayish brown (10 YR 4/3-5/2) clay loam, pale brown (10 YR 6/3) when dry; strong coarse subangular blocky; very firm; pH 7.4; strong effervescence; very to exceedingly angular gravelly to cobbly; abrupt, smooth boundary.
IIICca	75 - 99	Grayish brown to gray or light gray (10 YR 5/2-6/1) clay loam, light brownish gray to pale brown (10 YR 6/2-6/3) when dry; amorphous; firm; pH 7.6; strong effervescence; very cobbly; abrupt, smooth boundary.
IIIC	99 - 110 +	Grayish brown to light brownish gray (10 YR 5/2-6/2) clay loam, light gray (10 YR 7/2) when dry; amorphous; very firm; pH 7.6; strong effervescence.

Sub-group: Orthic Gray Luvisol

Profile No. S27

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	4-0	6.6	nd	nd	32.4	1.67	nd	5.9	.5	4.6	84.8	4.2	89.8	nd
Ae1	0-4	5.6	nd	nd	2.8	.19	nd	22.9	.0	5.7	68.6	2.8	16.3	nd
Ae2	4-19	6.0	nd	nd	2.3	.18	nd	16.6	.0	4.8	73.1	5.5	17.4	nd
IIAB	19-26	5.8	nd	nd	1.1	.09	nd	9.8	.0	5.2	78.4	6.6	18.3	nd
IIBt	26-52	6.3	nd	nd	1.0	.08	nd	6.5	5.3	3.6	79.8	4.8	18.3	nd
IIIBC	52-75	7.4	8.3	nd	1.6	.07	nd	nd	1.5	1.5	97.0	.0	20.4	nd
IIICca	75-99	7.6	10.5	nd	nd	nd	nd	nd	.0	1.4	98.6	.0	18.4	nd
IIIC	99-110+	7.6	11.2	nd	nd	nd	nd	nd	.3	1.1	98.6	.0	19.0	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	4-0	nd	nd	nd	nd	nd	nd	nd	nd	321.5	113.4	106.6	6.8	9.2	nd	nd	nd
Ae1	0-4	1	35	42	23	12	.98	61.4	63	35.6	20.5	9.7	10.8	1.8	nd	nd	nd
Ae2	4-19	1	34	42	24	13	.98	61.6	63	33.6	19.9	9.9	10.0	1.8	nd	nd	nd
IIAB	19-26	9	20	50	30	17	1.20	54.0	45	30.2	21.9	11.2	10.7	2.3	nd	nd	nd
IIBt	26-52	6	34	36	30	17	.90	65.8	73	31.4	20.5	10.5	10.0	2.2	nd	nd	nd
IIIBC	52-75	6	26	36	38	13	1.05	59.6	56	35.4	21.7	11.7	10.0	2.4	nd	nd	nd
IIICca	75-99	10	28	39	33	10	1.31	49.8	38	32.2	20.6	10.5	10.1	2.3	nd	nd	nd
IIIC	99-110+	9	26	35	39	16	1.35	48.7	36	32.9	21.9	11.7	10.2	2.1	nd	nd	nd

Sub-group: .... Cumulic Orthic Black.

Profile number: .... S 28.

Location: .... Between Survey Plots #48 and #64.

Vegetation: Shrub: .... <u>Rosa</u> sp..

Ground: .... <u>Phleum</u> sp., <u>Stipa</u> sp., <u>Geranium</u> sp., <u>Monarda</u> sp..

Parent material: .... Colluvium/Mixed Till 1.

Topography: .... Very steeply sloping; aspect WNW.

Elevation: .... 4570 ft. M.S.L..

Drainage: .... Moderately well.

Horizon	Depth (cm)	Description
L - F	2 - 0	Organic material in early stages of decomposition.
Ah1	0 - 19	Black (10 YR 2/1) clay loam, very dark gray (10 YR 3/1) when dry; weak, coarse prismatic breaking to strong, medium granular; friable; pH 6.2; abrupt, irregular boundary.
Ah2	19 - 47	Black to very dark brown (10 YR 2/1-2/2) clay loam, very dark gray to dark gray (10 YR 3/1-4/1) when dry; strong, coarse prismatic breaking to weak, medium subangular blocky; firm; pH 6.2; abrupt, irregular boundary.
AB	47 - 63	Very dark grayish brown (10 YR 3/2) clay loam, grayish brown (10 YR 5/2) when dry; strong, coarse prismatic breaking to weak,

Horizon	Depth (cm)	Description
AB	47 - 63	medium subangular blocky; firm; pH 6.2; very angular gravelly to moderately angular cobbly; abrupt, wavy boundary.
IIBm1	63 - 78	Brown to yellowish brown (10 YR 4/3-5/4) clay loam, yellowish brown to light yellowish brown (10 YR 5/4-6/4) when dry; strong, coarse subangular blocky breaking to weak, fine subangular blocky; very firm; pH 6.3; slightly to moderately channery; clear, smooth boundary.
IIBm2	78 - 99	Dark brown (10 YR 3/3) clay loam, yellowish brown (10 YR 5/4-6/4) when dry; strong, coarse prismatic breaking to strong, medium subangular blocky; very firm; pH 6.4; slightly angular gravelly; clear, smooth boundary.
IIBm3	99 - 115	Brown (10 YR 5/3) clay loam, grayish brown to pale brown (10 YR 5/2-6/3) when dry; strong, coarse prismatic breaking to medium subangular blocky; firm; pH 6.9; slightly angular gravelly; clear, smooth boundary.
IIBC	115 - 123 +	Grayish brown to brown (10 YR 5/2-5/3) clay loam, light gray (10 YR 7/2) when dry; weak, medium subangular blocky to amorphous; friable; pH 7.5; strong effervescence; slightly angular gravelly.

Sub-group: Cumulic Orthic Black

Profile No. S28

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-F	2-0	6.5	nd	nd	7.1	.6	nd	7.1	.3	5.3	81.7	5.6	37.4	nd
Ah1	0-19	6.2	nd	nd	5.3	.5	10.8	11.9	.4	2.5	77.3	7.9	32.0	nd
Ah2	19-47	6.2	nd	nd	3.6	.3	12.9	11.6	.4	2.1	74.7	11.2	28.4	nd
AB	47-63	6.2	nd	nd	1.4	.1	10.8	9.8	.5	2.2	76.0	11.5	21.2	nd
IIBm1	63-78	6.3	nd	nd	.6	.1	10.0	6.6	.6	1.8	71.8	19.2	17.8	nd
IIBm2	78-99	6.4	nd	nd	.5	.1	8.2	4.8	.5	1.4	77.1	16.2	22.3	nd
IIBm3	99-115	6.9	nd	nd	.5	.1	8.2	2.2	.4	1.7	77.2	18.5	22.0	nd
IIBC	115-123+	7.5	8.2	nd	1.5	nd	nd	nd	.7	1.0	89.7	8.6	18.9	nd

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-F	2-0	nd	nd	nd	nd	nd	nd	nd	nd	66.6	35.6	23.5	12.1	3.6	nd	nd	nd
Ah1	0-19	1	30	38	32	18	.96	58.6	60	60.2	30.0	20.5	9.5	4.6	nd	nd	nd
Ah2	19-47	1	28	40	32	18	1.08	56.6	53	44.4	25.5	15.2	10.3	3.3	nd	nd	nd
AB	47-63	8	27	43	30	16	1.01	60.9	60	35.0	20.3	10.9	9.4	2.4	nd	nd	nd
IIBm1	63-78	0	35	29	36	17	1.20	53.5	44	30.3	18.9	9.7	9.2	2.2	nd	nd	nd
IIIBm2	78-99	3	26	36	38	16	1.33	48.0	36	33.8	23.9	12.4	11.5	3.1	nd	nd	nd
IIBm3	99-115	0	24	38	38	20	1.52	40.6	27	37.5	24.7	12.4	12.3	3.1	nd	nd	nd
IIBC	115-123+	13	23	39	38	19	1.56	36.6	22	31.9	21.5	11.2	10.3	2.9	nd	nd	nd

Sub-group: .... Orthic Black.

Profile number: .... S 29.

Location: .... Near Survey Plot #46.

Vegetation: Tree: ....

Shrub: ....

Ground: .... *Phleum* sp., *Geranium* sp..

Parent material: .... Colluvium/Till.

Topography: .... Moderately sloping; aspect WNW.

Elevation: .... 4480 ft. M.S.L..

Drainage: .... Moderately well.

Horizon	Depth (cm)	Description
L - F	2 - 0	Organic material in early stages of decomposition.
Ah	0 - 34	Black (10 YR 2/1) clay loam to silty clay loam, very dark gray to dark gray (10 YR 3/1-4/1) when dry; strong, coarse prismatic breaking to fine granular; friable; pH 6.5; abrupt, wavy boundary.
AB	34 - 51	Very dark grayish brown to brown (10 YR 3/2-4/3) silty clay loam, gray (10 YR 5/1) when dry; strong, coarse prismatic breaking to medium subangular blocky; firm; pH 6.4; slightly channery; abrupt, wavy boundary.
Bm	51 - 72	Brown to dark brown (10 YR 4/3) clay loam, yellowish brown to light yellowish brown

Horizon	Depth (cm)	Description
Bm	51 - 72	(10 YR 5/4-6/4) when dry; strong, medium subangular blocky; firm; pH 6.6; moderately channery to cobbly; abrupt, smooth boundary.
IIBC	72 - 90	Brown (10 YR 5/3) loam, pale brown (10 YR 6/3) when dry; strong, fine to medium subangular blocky; friable; pH 7.5; strong effervescence; exceedingly angular gravelly to angular cobbly; abrupt, smooth boundary.
IICca	90 - 108 +	Grayish brown (10 YR 5/2) clay loam, light gray (10 YR 7/2) when dry; amorphous; friable; pH 7.7; strong effervescence; exceedingly angular cobbly.

Sub-group: Orthic Black

Profile No. S29

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis						pH-depend. C.E.C.
								exch. acid.	Na	K	Ca	Mg	TEC	
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-F	2-0	6.5	nd	nd	14.2	1.8	nd	11.8	.0	3.8	84.4	.0	28.5	nd
Ah	0-34	6.3	nd	nd	5.2	.5	10.9	9.3	.3	2.0	82.8	5.6	37.5	nd
AB	34-51	6.4	nd	nd	1.6	.2	10.0	7.3	.4	2.2	78.5	11.6	25.3	nd
Bm	51-72	6.6	nd	nd	.6	.1	8.6	5.1	.6	2.3	77.4	14.6	19.5	nd
IIBC	72-90	7.5	11.0	nd	1.8	.1	nd	nd	.4	1.2	98.4	.0	13.8	nd
IICca	90-108+	7.7	18.8	nd	nd	nd	nd	nd	.3	.8	98.9	.0	12.0	nd

Horizon	Depth	Mechanical Analysis					Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis					Free R_2O_3 (Oxalate)		
		G	S	Si	C	FC				Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-F	2-0	nd	nd	nd	nd	nd	nd	nd	nd	125.7	70.9	63.3	7.6	4.9	nd	nd	nd
Ah	0-34	1	20	49	31	11	.97	58.5	60	49.3	30.3	21.3	9.0	3.9	nd	nd	nd
AB	34-51	1	18	49	33	12	1.12	55.7	49	32.6	23.2	13.7	9.5	2.6	nd	nd	nd
Bm	51-72	6	27	44	29	16	1.30	50.0	38	28.6	19.8	10.4	9.4	2.0	nd	nd	nd
IIBC	72-90	16	37	38	25	12	1.40	46.6	33	25.3	16.5	7.5	9.0	1.2	nd	nd	nd
IICca	90-108+	16	39	32	29	14	1.34	49.6	37	24.0	16.1	7.4	8.7	1.0	nd	nd	nd

Sub-group: .... Carbonated Rego Humic Gleysol.

Profile number: .... S 30.

Location: .... Near Survey Plot #72.

Vegetation: Tree: ....

Shrub: ....

Ground: .... *Carex* sp., *Phleum* sp..

Parent material: .... Alluvium.

Topography: .... Gently sloping; aspect NE.

Elevation: .... 4375 ft. M.S.L..

Drainage: .... Poor.

Horizon	Depth (cm)	Description
L - H	3 - 0	Organic material in early stages of decomposition.
Ah1	0 - 16	Black (10 YR 2/1) silty clay loam, very dark gray (10 YR 3.1) when dry; weak, medium prismatic to strong, medium granular; friable; pH 7.1; abrupt, wavy boundary.
Ah2	16 - 52	Black to very dark gray (10 YR 2/1-3/1) silty clay loam, dark gray (10 YR 4/1) when dry; weak, medium subangular blocky breaking to strong, medium granular; firm; pH 7.6; slight effervescence; abrupt, smooth boundary.
ACg	52 - 68	Dark gray to gray (5 Y 4/1-5/1) silty clay loam, light gray (10 YR 7/1) when dry; weak, medium subangular blocky

Horizon	Depth (cm)	Description
ACg	52 - 68	breaking to strong, fine granular; firm; pH 8.1; strong effervescence; clear, smooth boundary.
Cg1	68 - 77	Grayish brown (10 YR 5/2) silt loam, light gray to very pale brown (10 YR 7/2-7/3) when dry; pseudo-platy to amorphous; friable; pH 8.2; strong effervescence; abrupt, smooth boundary.
Cg2	77 - 83	Grayish brown to pale brown (10 YR 5/2-6/3) silt loam, light gray to very pale brown (10 YR 7/2-8/3) when dry; pseudo-platy to amorphous; friable; pH 8.4; strong effervescence; abrupt, smooth boundary.
IIAhgb	83 - 114	Dark gray (5 Y 4/1) silty clay loam, gray to light gray (10 YR 6/1) when dry; strong, medium subangular blocky; firm; pH 8.3; strong effervescence; abrupt, smooth boundary.
IIICg	114 - 121	Grayish brown and yellowish red (10 YR 5/2 + 5 YR 5/6) loam, light gray to light brownish gray (10 YR 6/1-6/2) when dry; pseudo-platy to amorphous; very friable; pH 8.2; strong effervescence; abrupt, smooth boundary.
IV Ahgb	121 - 130 +	Dark brown (10 YR 3/3) silt loam to silty clay loam, gray to grayish brown (10YR 5/1 -5/2) when dry; amorphous; firm; pH 7.9 .

Sub-group: Carbonated Rego Humic Gleysol

Profile No. S30

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	3-0	7.4	1.6	nd	17.4	1.21	nd	nd	.3	3.9	85.7	10.1	61.7	nd
Ah1	0-16	7.1	0.3	nd	10.1	.84	12.0	nd	.4	1.0	91.8	6.8	55.6	nd
Ah2	16-52	7.6	0.2	3.0	nd	.27	nd	nd	.5	1.0	87.1	11.4	39.5	nd
ACg	52-68	8.1	16.8	2.9	nd	.12	nd	nd	.5	.7	98.7	.0	25.3	nd
Cg1	68-77	8.2	15.4	2.8	nd	.09	nd	nd	.5	.7	98.8	.0	22.9	nd
Cg2	77-83	8.4	12.2	2.1	nd	.07	nd	nd	.5	.8	98.7	.0	18.0	nd
IIAhgb	83-114	8.3	19.9	3.4	nd	.15	nd	nd	.2	1.1	98.7	.0	20.2	nd
IIICg	114-121	8.2	8.1	2.2	nd	.07	nd	nd	.3	.9	98.8	.0	11.5	nd
IV Ahgb	121-130+	7.9	1.7	1.2	nd	.12	nd	nd	.4	1.8	92.9	.0	21.0	nd

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	3-0	nd	nd	nd	nd	nd	nd	nd	nd	147.0	76.4	62.3	14.1	5.3	nd	nd	nd
Ah1	0-16	1	13	52	35	12	.78	62.1	80	63.1	43.9	30.1	13.8	9.8	.05	.06	.11
Ah2	16-52	0	13	48	39	11	.93	60.4	65	43.3	37.0	20.8	16.2	0.8	.01	.00	.01
ACg	52-68	1	8	61	31	11	.93	62.8	68	40.0	33.8	21.6	12.2	5.7	.02	.06	.08
Cg1	68-77	1	10	67	23	3	1.07	57.2	53	35.7	35.9	16.4	19.5	5.5	.02	.03	.05
Cg2	77-83	1	16	66	18	2	.88	63.8	73	42.9	38.3	13.3	25.0	6.0	.02	.11	.13
IIAhgb	83-114	1	17	54	29	7	1.24	50.6	41	40.6	33.6	19.2	14.4	5.0	.03	.03	.06
IIICg	114-121	1	41	40	19	10	1.45	45.1	31	24.9	22.5	8.3	14.2	2.3	.02	.07	.09
IVAhgb	121-130+	1	19	54	27	9	1.26	50.8	41	31.2	28.4	12.0	16.4	3.7	.04	.00	.04

APPENDIX III-A

Key to Abbreviations

Slope:

d - moderately sloping	(6 - 9%)
e - strongly sloping	(10 - 15%)
f - steeply sloping	(16 - 30%)
g - very steeply sloping	(31 - 60%)
h - excessively sloping	($>$ 60%)

Internal Drainage:

1 - rapid
2 - well
3 - moderately well
4 - imperfect
5 - poor
6 - very poor

Depth and Nature of Organic Horizons:

P - peat
T - turf
a - L-H $<$ 5 cm
b - L-H $\geq$ 5 cm $<$ 121/2 cm
c - L-H $\geq$ 121/2 cm

Nature of Overlay:

C - colluvium
sort. C - sorted colluvium
R.C. - residual colluvium
A - aeolian
All - alluvium
Lac - lacustrine

Parent Material:

TI - comminuted till
TIIB - stony till
TIIA - stone-free till, highly compacted
C - colluvium
R.C. - residual colluvium
Sh - shale
Res - residual
R - rock
All - alluvium
Lac - lacustrine

Order	Great Group	Subgroup	Code	Slope	Inter. Drain.	Depth & Nature Org. Hor.	Depth & Nature Overlay (cm)	Parent Material (cm)	Depth Bedrock (cm)	Area (acres)
Luvisolic	Gray Luvisol	Orthic	A 1	e	3	a	C <15	TIIA		77
			2	d	3	a	C <15	TIIA		62
			3	f	3	a	C >15	TIIB		17
			4	e	3	a	C <15	TIIA/R	<90	46
			5	e	3	a	C <15	TIIB		13
			6	f	3	a	RC <15	TIIA/R	<90	13
			7	g	3	a	C >15	TIIB		15
			8	e	3	a	C >15	TIIB/R	<90	38
			9	f	3	a	C <15	TIIA/R	<90	78
			B 1	f	2	a	C >15	C/R	<60	37
			2	e	3	a	C <15	TIIB/R	<60	11
			3	g	3	a	C >15	TIIB/R	<90	11
			4	e	3	a	A+C <15	TIIB/R	<90	4
			5	e	3	a	C >15	C/R	<30	25
			6	e	3	b	C >15	TIIA		6
			7	g	3	b	C >15	TIIB		16
			8	e	2	a	C <15	TIIB		9
			9	f	2	a	C >15	TIIB/R	<90	5
			C 1	f	3	a	C <15	TIIB/R	<90	22
			2	f	3	a	C <15	TIIA		18
			3	e	3	a	RC >15	RC/R	<60	19
			4	f	3	a	C <15	TIIB		1
		Dark	D 6	d	3	a	C >15	TIIA/Sh		32
			7	g	3	a	C >15	TIIA		14
		Bisequa	E 8	e	3	a	C+A <15	TIIB/R	<90	81
			9	d	3	a	C >15	TIIA/Sh		1

Order	Great Group	Subgroup	Code	Slope	Inter. Drain.	Depth & Nature Org. Hor.	Depth & Nature Overlay (cm)	Parent Material (cm)	Depth Bedrock (cm)	Area (acres)
		Brunisolic	F 1	f	3	a	C > 15	TIIB		5
			2	e	3	a	sortC > 15	TI		25
			3	g	3	a	C > 15	TIIB		32
Luvisolic	Gray Luvisol	Brunisolic, Gleyed	G 4	e	4	b	C+A > 15	TIIA		11
			5	f	4	a	C+A > 15	TIIB		12
			6	e	4	a	C < 15	TIIB/R	< 90	11
			7	g	4	b	C > 15	TIIA		36
			8	f	4	a	C > 15	TIIA/R	< 90	15
			9	e	4	b	C > 15	TIIA		4
		Orthic, Gleyed	H 1	d	4	a	C > 15	TIIA/Sh/R	< 90	28
			2	e	4	b	C > 15	TIIB		41
			3	e	4	a	C > 15	TIIB		45
			4	e	4	c	C > 15	TIIB		24
			5	f	4	a	C < 15	TI		11
			6	f	4	a	C < 15	TIIA		44
			7	d	4	a	C+A < 15	TIIA		8
			8	g	4	a	C > 15	TIIA		23
			9	f	4	a	C < 15	TIIA/Sh/R	< 90	11
			J 1	e	4	a	C < 15	TIIA/R	< 30	4
			2	d	4	a	C < 15	TIIA/Sh		20
			3	e	4	a	C < 15	TIIA		20
Brunsolic	Eutric Brunisol	Orthic	K 1	g	3	T	C > 15	Sh		2
		Degraded	L 1	f	3	c	C > 15	C/R	< 90	8
			2	e	3	a	C > 15	C		2
			3	e	2	b	C > 15	TIIA		18
			4	e	3	b	C > 15	A/TIIB/R	< 90	12

Order	Great Group	Subgroup	Code	Slope	Inter. Drain.	Depth & Nature Org. Hor.	Depth & Nature Overlay (cm)	Parent Material (cm)	Depth Bedrock (cm)	Area (acres)
Brunisolic	Eutric Brunisol	Degraded	L 5	g	3	b	C > 15	TIIA/Sh		7
			6	h	1	a	C > 15	C/R	< 30	7
			7	f	3	a	RC < 15	Res/R	< 30	3
			8	g	3	a	C > 15	TIIA		11
			9	f	3	a	C > 15	TIIA		10
			M 1	g	2	a	C > 15	C/R	< 30	11
			2	f	3	b	C > 15	C/R	< 90	12
			3	g	2	a	C < 15	RC/R	< 30	14
	Brunisol	Degraded	4	f	2	a	C > 15	C/R	< 90	15
			5	f	3	b	C > 15	TIIB/R	< 90	22
		Degraded, Gleyed	N 1	e	4	a	C < 15	TIIA/R	< 30	5
			2	g	4	b	C < 15	TIIA/Sh		7
Brunisolic	Dystric Brunisol	Degraded	P 1	d	3	a	C+A > 15	TIIB/R	< 90	15
			2	e	3	a	Lac	Lac		6
	Eutric Brunisol	Orthic Gleyed	Q 1	f	4	c	C > 15	TI		15
Regosolic	Regosol	Orthic	R 1	e	2	T	C > 15	C		11
		Orthic (Formerly Deorcic)	S 1	e	1	T	All	All/All		3
			2	f	3	a	C > 15	TI		3
			3	f	4	b	C > 15	TIIA		3
Chernozemic	Black	Rego and Cumulic Rego	T 1	f	3	T	C > 15	C/TIIA		2

Order	Great Group	Subgroup	Code	Slope	Inter. Drain.	Depth & Nature Org. Hor.	Depth & Nature Overlay (cm)	Parent Material (cm)	Depth Bedrock (cm)	Area (acres)
Chernozemic	Black	Rego and Cumulic Rego	T 2	d	3	a	C > 15	C		3
			3	f	3	T	C > 15	C		3
			4	c	3	T	C > 15	C		3
			5	e	3	a	RC > 15	RC/R	< 30	11
	Black	Gleyed Rego & Cumulic Rego	U 1	e	4	T	C > 15	C/R	< 90	11
	Dark Gray	Rego, Cumulic	V 1	f	2	b	C > 15	C		24
Organic	Fibrisol	Ternic	W 1	d	5	p	C > 15	TIIA		10
Gleysolic	Humic Gleysol	Orthic	X 1	g	5	P	C > 15	C/R	< 60	5
			2	f	5	P	C > 15	C		8
			3	e	5	P	All > 15	All/R	> 90	40
		Rego	Y 1	f	6	P	C > 15	C/R	< 60	7
			2	d	5	P	C > 15	C/R	< 60	6
Gleysolic	Gleysol	Rego, Peaty	Z 1	f	5	P	C > 15	C/R	> 30	12
		Rego, Peaty Carbonated	Z 5	e	5	C	C > 15	C		11

APPENDIX III-E

Key to Appendix III-B

The morphological descriptions and analytical results of the soil profiles sampled in Deer Creek Basin are presented in order of sampling site sequence. Explanation of abbreviations used are as follows:

Ino. C - Inorganic Carbon

Org. C - Organic Carbon

Exch. Acid. - Exchange Acidity

pH Depend. C.E.C. - pH Dependend Cation Exchange Capacity

G - Coarse skeleton (> 2 mm)

S - Sand (2 mm - 50 μ)

Si - Silt (50 μ - 2 μ)

C - Clay (2 μ - .2 μ)

FC - Fine clay (< .2 μ)

Bulk Dens. - Bulk Density

Por. - Porosity (calculated from bulk density and specific gravity data

Sat. Cap. - Saturation Capacity

(Theor.) - Theoretical Saturation Capacity (Richards and Wadleigh, 1952)

Avail. Moist. - Available Moisture

Hygr. Moist. - Hygroscopic Moisture

Sub-group: .... Degraded Dystric Brunisol.

Profile number: .... D 1.

Location: .... Near Forestry Plot #12.

Vegetation: Tree canopy: .... *Populus tremuloides*, *Pinus contorta*.

Understory: .... *Shepherdia* sp., *Juniperus* sp..

Ground: .... *Elymus* sp., *Aster* sp..

Parent material: .... Lacustrine/Lacustrine/Till 1.

Topography: .... Moderately sloping; aspect SSE.

Elevation: .... 4510 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	5 - 0	Organic material in various stages of decomposition.
Aej	0 - 8	Dark brown to brown (10 YR 2/3-4 3) silt loam, pale brown to light yellowish brown (10 YR 6/3-6/4) when dry; weak, coarse platy; friable; pH 5.5; clear, wavy boundary.
Btj	8 - 17	Dark yellowish brown (10 YR 3/4) loam, brown to dark brown (10 YR 4/3) when dry; weak, medium subangular blocky breaking to strong, medium granular; friable; pH 5.4; gradual, wavy boundary.
C	17 - 62	Very dark grayish brown (10 YR 3/2) clay loam, dark brown to dark grayish brown (10 YR 3/3-4/2) when dry; strong, coarse granular; firm; pH 5.6; abrupt, smooth

Horizon	Depth (cm)	Description
C	17 - 62	boundary.
IIAh	62 - 67	Black (10 YR 2/1) clay loam, very dark grayish brown (10 YR 3/2) when dry; strong, medium subangular blocky; friable; pH 5.8; clear, wavy boundary.
IIAC	67 - 73	Very dark grayish brown (10 YR 3/2) clay loam to silty clay loam, dark grayish brown (10 YR 4/2) when dry; amorphous; friable; pH 5.9; clear, wavy boundary.
IIC	73 - 92	Dark grayish brown to grayish brown (10 YR 4/2-5/2) loam, grayish brown to brown (10 YR 5/2-5/3) when dry; amorphous; friable; pH 7.2; slight effervescence; abrupt, smooth boundary.
IIIAh	92 - 94	Black (10 YR 2/1) clay loam, very dark grayish brown (10 YR 3/2) when dry; amorphous; friable; strong effervescence; abrupt, wavy boundary.
IIIC	94 - 110 +	Grayish brown (10 YR 5/2) silty clay loam, light brownish gray to light gray (10 YR 6/2-7/1) when dry; amorphous; friable; strong effervescence; moderately angular gravelly.

Sub-group: Degraded Dystric Brunisol Profile No.: D1.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	5-0	5.1	n.d.	n.d.	n.d.	n.d.	n.d.	36.5	.0	3.5	60.0	0	77.1	n.d.
Aej	0-8	5.5	n.d.	n.d.	1.5	.11	14	22.5	.6	1.7	69.7	5.5	18.4	87.2
Btj	8-17	5.4	n.d.	n.d.	1.0	.09	11	18.9	.0	1.5	74.3	5.3	21.5	87.1
C	17-62	5.6	n.d.	n.d.	1.4	n.d.	n.d.	10.8	.4	1.7	81.7	5.4	25.0	88.7
IIAh	62-67	5.8	n.d.	n.d.	2.2	.18	12	11.0	.4	1.1	84.2	3.3	28.9	n.d.
IIAC	67-73	5.9	n.d.	n.d.	1.4	.13	11	10.3	.4	1.4	75.9	12.0	26.0	n.d.
IIC	73-85+	7.2	8.6	1.03	n.d.	n.d.	n.d.	.0	.4	.9	98.7	0	21.4	n.d.

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	5-0	n.d	n.d.	n.d.	n.d.	nd	n.d.	n.d.	n.d.	348.4	112.1	101.2	10.9	4.5	n.d.	n.d.	n.d.
Aej	0-8	n.d.	29	52	19	6	.99	63.4	64	38.4	26.5	9.1	17.4	.8	.23	.11	.34
Btj	8-17	n.d	27	48	25	10	1.35	50.0	37	29.2	22.3	16.6	5.7	.8	.33	.08	.41
C	17-62	n.d.	24	47	29	13	1.18	56.3	48	31.1	26.1	11.9	14.2	.9	.18	.10	.28
IIAh	62-67	n.d.	27	45	28	11	1.14	57.8	51	34.4	26.4	12.9	13.5	1.1	.13	.05	.18
IIAC	67-73	n.d.	20	49	31	14	1.14	57.8	51	31.6	28.5	13.0	15.5	.9	.24	.05	.29
IIC	73-85	n.d.	31	45	24	10	1.13	58.2	51	38.8	24.9	11.1	13.8	.7	.02	.05	.07

Sub-group: .... Orthic Gray Luvisol.

Profile number: .... D 2.

Location: .... Near Forestry Plot #39.

Vegetation: Tree canopy: .... Pinus sp., Picea sp..

Understory: .... Shepherdia sp., Rosa sp., Juniperus sp..

Ground: .... Vaccinum vitis-idea, Hylocomium sp., Linaea sp..

Parent material: .... Colluvium/Till 1.

Topography: .... Strongly sloping; aspect W..

Elevation: .... 4620 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	5 - 0	Organic material in various stages of decomposition.
Ae	0 - 13	Dark grayish brown (10 YR 4/2) silt loam, light brownish gray to pale brown (10 YR 6/2-6/3) when dry; strong, coarse platy; pH 5.3; abrupt, wavy boundary.
IIBt1	13 - 28	Dark yellowish brown to yellowish brown (10 YR 4/4-5/4) clay loam, brown to yellowish brown (10 YR 5/3-5/4) when dry; strong, medium subangular blocky; firm; pH 5.3; slightly to moderately angular cobbly; gradual, smooth boundary.
IIBt2	28 - 44	Brown to dark brown (10 YR 4/3) clay loam, brown (10 YR 5/3) when dry; strong, coarse

Horizon	Depth (cm)	Description
IIBt2	28 - 44	subangular blocky; firm; pH 5.3; slightly to moderately angular cobbly; clear, smooth boundary.
IIBC	44 - 66	Dark brown to brown (10 YR 2/3-4/3) loam, brown (10 YR 5/3) when dry; weak, coarse subangular blocky to strong, medium granular; friable; pH 5.3; slightly to moderately angular cobbly; gradual, wavy boundary.
IIC	66 - 92 +	Dark grayish brown to brown (10 YR 4/2-4/3) silt loam, brown to light brownish gray (10 YR 5/3-6/2) when dry; pseudo-platy to amorphous; friable; pH 5.4; slightly to moderately angular cobbly.

Sub-group: Orthic Gray Luvisol Profile No.: D2.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	5-0	4.5	n.d.	n.d.	n.d.	n.d.	n.d.	50.6	.6	4.5	38.0	6.3	80.9	n.d.
Ae	0-13	5.3	n.d.	n.d.	1.91	.10	19.1	30.1	.6	3.7	57.0	8.6	18.6	n.d.
IIBt1	13-28	5.3	n.d.	n.d.	0.58	.05	11.6	12.0	.4	2.8	71.9	12.9	27.9	n.d.
IIBt2	28-44	5.3	n.d.	n.d.	0.60	.04	15.0	13.0	.4	2.0	71.2	13.4	25.9	n.d.
IIBC	44-66	5.3	n.d.	n.d.	n.d.	.04	n.d.	12.9	1.0	2.0	74.6	9.5	22.2	n.d.
IIC	66-92+	5.4	n.d.	n.d.	n.d.	n.d.	n.d.	10.2	.4	1.6	71.5	16.3	26.6	n.d.

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	5-0	n.d.	n.d.	n.d.	n.d.	nd	n.d.	n.d.	n.d.	415.0	116.9	90.6	26.3	3.81	n.d.	n.d.	n.d.
Ae	0-13	n.d.	28	52	20	7	1.17	56.7	48	38.7	27.8	9.6	18.2	.93	n.d.	n.d.	n.d.
IIBt1	13-28	1	30	35	35	16	1.38	48.9	35	33.4	23.4	13.3	10.1	1.43	n.d.	n.d.	n.d.
IIBt2	28-44	5	32	36	32	14	1.40	48.2	34	30.8	20.4	12.0	8.4	1.00	n.d.	n.d.	n.d.
IIBC	44-66	11	38	38	24	11	1.49	44.9	30	26.7	19.5	10.2	9.3	.93	n.d.	n.d.	n.d.
IIC	66-92+	n.d.	21	59.5	19.5	7	1.40	48.2	34	33.7	24.0	11.5	12.5	.22	n.d.	n.d.	n.d.

Sub-group: .... Gleyed Eutric Brunisol.

Profile number: .... D 3.

Location: .... Between Forestry Plots #172 and #171.

Vegetation: Tree canopy: .... Picea sp..

Understory: .... Salix sp., Rosa sp..

Ground: .... Mnium sp., Carex sp..

Parent material: .... Till 1.

Topography: .... Moderately sloping; aspect WNW..

Elevation: .... 4800 ft. M.S.L..

Drainage: .... Imperfect.

Horizon	Depth (cm)	Description
L	14 - 12	Matted, undecayed organic material.
F	12 - 6	Fermented organic material.
H	6 - 0	Humus; altered organic material.
Bfj	0 - 15	Dark reddish brown (5 YR 3/4) clay loam, brown (10 YR 5/3) when dry; strong, medium granular; firm; pH 7.1; slight effervescence; slightly to moderately angular gravelly; clear, wavy boundary.
BC	15 - 37	Brown to grayish brown (10 YR 4/3-5/2) loam to clay loam, light brownish gray to pale brown (10 YR 6/2-6/3) when dry; strong, medium granular; friable; pH 7.2; slight effervescence; slightly to moderately angular gravelly; gradual, wavy boundary.

Horizon	Depth (cm)	Description
Cg	37 - 78 +	Grayish brown to light brownish gray (10 YR 5/2-6/2) loam, pale brown to light gray (10 YR 6/3-7/2) when dry; amorphous; friable; pH 7.3; strong effervescence; moderately angular gravelly.

Sub-group: Gleyed Eutric Brunisol Profile No.: D3.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-F	14-6	5.8	n.d.	n.d.	n.d.	n.d.	n.d.	20.4	.6	1.2	75.4	2.4	119.2	n.d.
H	6-0	7.0	n.d.	n.d.	n.d.	n.d.	n.d.	4.3	.3	.5	92.5	2.4	130.6	n.d.
Bfj	0-15	7.1	0.12	0.01	1.79	.09	n.d.	n.d.	.5	2.3	90.0	7.2	24.0	n.d.
BCg	15-37	7.2	4.16	0.50	n.d.	.08	n.d.	n.d.	1.0	2.0	91.7	5.3	19.4	n.d.
Cg	37-78	7.3	7.68	0.92	n.d.	n.d.	n.d.	n.d.	.7	1.4	91.4	6.5	16.6	n.d.

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-F	14-6	n.d.	n.d.	n.d.	n.d.	n.d	n.d.	n.d.	n.d.	452.0	169.5	111.0	58.5	5.04	n.d.	n.d.	n.d.
H	6-0	n.d.	n.d.	n.d.	n.d.	n.d	n.d.	n.d.	n.d.	261.0	147.5	91.5	56.0	5.06	n.d.	n.d.	n.d.
Bfj	0-15	7	22	47	31	14	1.20	55.6	46	36.8	25.5	11.4	14.1	1.03	.05	.05	.10
BCg	15-37	8	31	42	27	13	1.50	44.5	30	33.3	24.1	11.3	12.8	.79	.05	.02	.07
Cg	37-78	16	33	45	22	8	1.61	40.4	25	26.7	20.6	9.5	11.1	.71	.05	.03	.08

Sub-group: .... Cumulic Rego Black.

Profile number: .... D 4.

Location: .... Near Forestry Plot #226.

Vegetation: Tree canopy: .... *Populus* sp., *Pinus* sp..

Understory: ....

Ground: .... *Elymus* sp., *Aster* sp., *Delphinium* sp..

Parent material: .... Colluvium.

Topography: .... Strongly sloping; aspect SE..

Elevation: .... 4850 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - F	2 - 0	Organic material in early stages of decomposition.
Ah1	0 - 9	Black (10 YR 2/1) silt loam, black (10 YR 2/1) when dry; strong, fine granular; very friable; pH 6.8; clear, wavy boundary.
Ah2	9 - 33	Black to very dark brown (10 YR 2/1-2/2) silty clay loam, very dark grayish brown (10 YR 3/2) when dry; strong, coarse prismatic; friable; pH 7.0; slightly channery; abrupt, smooth boundary.
AC1	33 - 54	Very dark grayish brown to dark brown (10 YR 3/2-3/3) silt loam, brown (10 YR 5/3) when dry; weak, coarse prismatic breaking to strong, coarse subangular

Horizon	Depth (cm)	Description
AC1	33 - 54	blocky; friable; pH 6.8; slightly to moderately channery; gradual, smooth boundary.
AC2	54 - 78 +	Dark brown to dark grayish brown (10 YR 3/3-4/2) silt loam, pale brown (10 YR 6/3) when dry; strong, fine subangular blocky; firm; pH 7.3; strong effervescence; slightly channery.

Sub-group: Cumulic Rego Black Profile No.: D4.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-F	2-0	7.2	2.7	.3	nd	nd	nd	nd	.1	3.8	95.1	1.0	99.5	nd
Ah1	0-9	6.8	nd	nd	16.8	.55	31	5.1	.1	1.0	89.2	4.6	83.9	nd
Ah2	9-33	7.0	nd	nd	4.1	.32	13	2.4	.3	1.5	87.9	7.9	36.3	nd
AC1	33-54	6.8	nd	nd	2.2	.16	14	1.2	1.2	2.0	84.5	11.1	24.9	nd
AC2	54-78+	7.3	12.8	1.5	1.4	.10	13	nd	.3	1.7	97.3	.7	16.6	nd

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-F	2-0	nd	nd	nd	nd	nd	nd	nd	nd	nd	157.2	125.4	31.8	4.6	nd	nd	nd
Ah1	0-9	0	23	52	25	8	.45	83.4	185	179.5	83.4	59.9	23.5	2.8	nd	nd	nd
Ah2	9-33	5	18	54	28	10	1.07	60.4	56	53.4	33.3	15.8	17.5	1.2	.85	.02	.87
AC1	33-54	7	21	53	26	10	1.17	56.7	48	38.4	25.9	12.1	13.8	.9	nd	nd	nd
AC2	54-78+	3	18	56	26	10	1.38	48.9	35	37.7	21.8	9.8	12.0	1.0	.73	.01	.74

Sub-group:	Cumulic Regosol.
Profile number:	D 5.
Location:	Between Forestry Plots #155 and #173.
Vegetation: Tree canopy:	*Populus tremuloides*, *Populus* sp..
Understory:	*Rosa* sp..
Ground:	*Elymus* sp., *Aster* sp..
Parent material:	Colluvium/Till II A..
Topography:	Strongly sloping; aspect S..
Elevation:	4750 ft. M.S.L..
Drainage:	Well.

Horizon	Depth (cm)	Description
L - H	2 - 0	Organic material in various stages of decomposition.
Ajh1	0 - 30	Very dark grayish brown to dark brown (10 YR 3/2-3/3) silty clay loam, brown (10 YR 5/3) when dry; strong, medium subangular blocky; friable; pH 6.6; slightly angular cobbly; gradual smooth boundary.
Ahj2	30 - 60	Dark brown (10 YR 3/3) silt loam, brown to pale brown (10 YR 5/3-6/3) when dry; weak, coarse prismatic breaking to strong, fine subangular blocky; friable; pH 6.9; slightly angular cobbly; clear, smooth boundary.

Horizon	Depth (cm)	Description
IIBC	60 - 78	Dark brown to dark grayish brown (10 YR 3/3-4/2) loam, light brownish gray (10 YR 6/2) when dry; weak, medium subangular blocky; friable; pH 6.9; moderately to very angular cobbly to channery; gradual, smooth boundary.
IIC	78 - 90 +	Dark grayish brown to dark brown (10 YR 4/2-3/3) loam to clay loam, pale brown to light gray (10 YR 6/3-7/2) when dry; pseudo platy to amorphous; friable; pH 7.2; strong effervescence; moderately to very angular cobbly to channery.

Sub-group: Cumulic Regosol

Profile No.: D5.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	2-0	5.9	nd	nd	nd	nd	nd	14.6	.1	4.0	81.3	.0	110.9	nd
Ahj1	0-30	6.6	nd	nd	2.85	.20	14	5.7	.4	1.5	82.8	9.6	27.5	nd
Ahj2	30-60	6.9	nd	nd	1.56	.12	13	3.3	.0	2.4	84.4	9.9	21.4	nd
IIBC	60-78	6.9	nd	nd	nd	.08	nd	1.7	.4	1.2	88.4	8.3	21.2	nd
IIC	78-90+	7.2	5.0	.6	nd	nd	nd	nd	.4	1.1	89.0	9.5	19.9	nd

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	2-0	nd	nd	nd	nd	nd	nd	nd	nd	448.0	181.0	146.8	34.2	5.6	nd	nd	nd
Ahj1	0-30	0	17	53	30	14	1.14	57.8	51	40.6	27.2	14.3	12.9	1.4	1.03	.03	1.06
Ahj2	30-60	6	18	56	26	14	1.21	55.2	46	28.3	23.4	11.1	12.3	1.0	.87	.02	.89
IIBC	60-78	17	32	44	24	6	1.19	56.0	44	27.9	27.9	9.5	9.7	1.0	nd	nd	nd
IIC	78-90	9	29	44	27	9	1.19	56.0	44	27.0	27.0	10.3	10.7	1.0	.87	.02	.89

Sub-group: .... Orthic Gray Luvisol.

Profile number: .... D 6.

Location: .... Near Forestry Plot #280.

Vegetation: Tree canopy: .... Pinus contorta, Picea sp..

Understory: .... Alnus sp..

Ground: .... Calamagrostis sp., Aster sp., Hylocomium sp..

Parent material: .... Colluvium/Till II B.

Topography: .... Very steeply sloping; aspect SSI..

Elevation: .... 5100 ft. M.S.L..

Drainage: .... Well.

Horizon	Depth (cm)	Description
L - H	4 - 0	Organic material in various stages of decomposition.
Ae	0 - 13	Grayish brown (10 YR 5/2) silt loam, light brownish gray to pale brown (10 YR 6/2-6/3) when dry; strong, coarse platy; very friable; pH 5.4; moderately to very channery; clear, wavy boundary.
AB	13 - 18	Brown to pale brown (10 YR 5/3-6/3) loam, pale brown to light yellowish brown (10 YR 6/3-6/4) when dry; weak, coarse subangular blocky; friable; pH 5.3; moderately to very channery; gradual, smooth boundary.

Horizon	Depth (cm)	Description
IIBt	18 - 32	Yellowish brown to light yellowish brown (10 YR 5/4-6/4) silt loam to silty clay loam, light yellowish brown to very pale brown (10 YR 6/4-7/3) when dry; strong, medium subangular blocky; firm; pH 5.5; very angular cobbly; clear, smooth boundary.
IIBC	32 - 50	Brown (10 YR 5/3) silty clay loam, pale brown (10 YR 6/3) when dry; strong, medium subangular blocky; firm; pH 5.7; moderately to very angular cobbly; clear, smooth boundary.
IIC	50 - 80 +	Dark barown to dark grayish brown (10 YR 3/3-4/2) silty clay loam, light brownish gray to pale brown (10 YR 6/2-6/3) when dry; pseudo blocky to amcrphous; firm; pH 6.2; moderately to very angular cobbly.

Sub-group: Orthic Gray Luvisol Profile No.: D6.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	4-0	5.4	nd	nd	nd	nd	nd	33.6	.2	5.2	57.7	3.3	67.6	nd
Ae	0-13	5.4	nd	nd	1.51	.09	16.8	37.2	.0	3.1	41.9	17.8	12.2	nd
AB	13-18	5.3	nd	nd	0.77	.06	12.8	26.1	.0	2.7	62.2	9.0	11.0	nd
IIBt	18-32	5.5	nd	nd	.71	.06	11.8	15.3	.0	3.2	63.1	18.4	14.3	nd
IIBC	32-50	5.7	nd	nd	nd	.06	nd	11.6	.6	2.9	70.5	14.4	18.0	nd
IIC	50-80+	6.2	nd	nd	nd	nd	nd	5.9	.5	2.5	75.4	15.7	20.5	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	4-0	nd	nd	nd	nd	nd	nd	nd	nd	240.5	110.7	94.8	15.9	3.84	nd	nd	nd
Ae	0-13	9	28	58	14	4	1.00	63.0	63	36.0	24.2	7.6	16.6	.69	nd	nd	nd
AB	13-18	24	37	48	15	4	nd	nd	nd	23.1	18.0	6.0	12.0	.62	nd	nd	nd
IIBt	18-32	14	19	53	28	10	1.22	54.9	45	24.7	19.9	8.4	11.5	.77	nd	nd	nd
IIBC	32-50	9	12	56	32	14	1.38	48.9	35	26.3	22.8	10.8	12.0	.75	nd	nd	nd
IIC	50-80+	11	17	45	38	14	1.40	48.2	34	30.7	26.1	12.3	13.8	.99	nd	nd	nd

Sub-group: .... Carbonated Rego Gleysol.

Profile number: .... D 7.

Location: .... Between Forestry Plots #130 and #131.

Vegetation: Tree canopy: .... _Picea_ sp., _Pinus_ contorta.

Understory: .... _Salix_ sp., _Betula_ sp., _Rosa_ sp..

Ground: .... _Hylocomium_ sp., _Equisetum_ sp..

Parent material: .... Alluvium.

Topography: .... Strongly sloping; aspect E..

Elevation: .... 4900 ft. M.S.L..

Drainage: .... Poor.

Horizon	Depth (cm)	Description
L	10 - 8	Matter, undecayed organic material.
F - H	8 - 0	Spongy, partially and fully decayed organic material.
C	0 - 10	Very dark gray (10 YR 3/1) silty clay, dark gray to grayish brown (10 YR 4/1-5/2) when dry; amorphous; firm; pH 7.5; strong effervescence; abrupt, smooth boundary.
IIF - H	10 - 20	Spongy, partially and fully decayed organic material.
IIC	20 - 45	Very dark gray to dark gray (10 YR 3/1-4/1) silty clay loam to silty clay, gray (10 YR 5/1) when dry; amorphous; friable; pH 7.4; strong effervescence; slightly channery; abrupt, smooth boundary.

Horizon	Depth (cm)	Description
IIIH	45 - 47	Humus; altered organic material.
IIIC	47 - 80 +	Very dark gray to dark gray (10 YR 3/1-4/1) silty clay loam to silty clay, gray (10 YR 5/1) when dry; amorphous; friable; strong effervescence; slightly channery.

Sub-group: Carbonated Rego Gleysol   Profile No.: D7.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis: exch. acid.	Na	K	Ca	Mg	TEC	pH depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L	10-8	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
F-H	8-0	7.0	nd	nd	nd	nd	nd	1.7	.2	.9	97.2	.0	143.14	nd
C	0-10	7.5	17.32	2.08	nd	nd	nd	nd	.2	.8	98.8	.0	41.6	nd
IIF-H	10-20	7.2	3.17	0.38	nd	nd	nd	nd	.3	.3	95.3	.0	158.7	nd
IIC	20-45	7.4	17.74	2.13	nd	nd	nd	nd	1.0	.8	97.3	.0	45.9	nd
IIIH	45-47	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
IIIC	47-80+	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Horizon	Depth	Mechanical Analysis: G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis: Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate): Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L	10-8	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
F-H	8-0	nd	nd	nd	nd	nd	nd	nd	nd	361.0	200.4	125.1	75.3	7.2	nd	nd	nd
C	0-10	0	9	50	41	15	.68	74.9	110	88.1	63.0	26.0	37.0	2.07	nd	nd	nd
IIF-H	10-20	nd	nd	nd	nd	nd	nd	nd	nd	298.5	183.3	114.6	68.7	5.9	nd	nd	nd
IIC	20-45	0	13	47	40	16	.71	73.8	104	80.5	58.6	21.6	37.0	1.8	nd	nd	nd
IIIH	45-47	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd
IIIC	47-80+	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Sub-group: .... Gleyed Gray Luvisol.

Profile number: .... D 8.

Location: .... Near Forestry Plot #120.

Vegetation: Tree canopy: .... Pinus contorta; picea sp..

Understory: .... Alnus sp., Shepherdia sp..

Ground: .... Aster sp., Hylocomium sp..

Parent material: .... Colluvium/Till IIA/Residual/Rock.

Topography: .... Steeply sloping; aspect SW..

Elevation: .... 4900 ft. M.S.L..

Drainage: .... Imperfect to poor.

Horizon	Depth (cm)	Description
L - H	3 - 0	Organic material in various stages of decomposition.
Ae	0 - 5	Brown to grayish brown (10 YR 4/3-5/2) silt loam, light gray (10 YR 7/2) when dry; strong, coarse platy; very friable; pH 5.4; abrupt, wavy boundary.
AB	5 - 16	Brown (10 YR 5/3) silt loam to silty clay loam, very pale brown (10 YR 7/3) when dry; weak, medium subangular blocky breaking to strong, coarse platy; friable; pH 5.5; slightly gravelly; clear, smooth boundary.
IIBt1	16 - 29	Grayish brown (10 YR 5/2) silty clay to clay, light brownish gray to pale brown (10 YR 6/2-6/3) when dry; strong, coarse

Horizon	Depth (cm)	Description
IIBt1	16 - 29	columnar breaking to strong, coarse subangular blocky; very firm; pH 5.1; slightly gravelly to cobbly; clear, wavy boundary.
IIBt2	29 - 44	Dark yellowish brown (10 YR 4/4) silty clay, light yellowish brown (10 YR 2/4) when dry; strong, medium subangular blocky; very firm; pH 5.2; slightly to moderately channery; gradual, smooth boundary.
IIBC	44 - 58	Dark grayish brown (10 YR 4/2) clay, light brownish gray (10 YR 6/2) when dry; amorphous; very firm; pH 5.4; slightly gravelly; gradual, smooth boundary.
IIC	58 - 76	Dark brown to dark grayish brown (10 YR 3/3-4/2) silty clay loam, grayish brown to brown (10 YR 5/2-5/3) when dry; pseudoplaty to amorphous; firm; pH 5.4; slightly gravelly; clear, smooth boundary.
IIIC	76 - 98	Dark brown (10 YR 3/3) loam, grayish brown to brown (10 YR 6/3-6/4) when dry; amorphous to single grained, friable; pH 6.6; exceedingly channery; abrupt, broken boundary.
Rock	98 +	Sandstone.

Sub-group: Gleyed Gray Luvisol

Profile No.: D8.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	3-0	5.0	nd	nd	nd	nd	nd	36.5	.3	4.5	55.3	3.4	75.2	nd
Ae	0-5	5.4	nd	nd	1.20	.08	15.0	25.2	3.6	3.6	64.9	2.7	11.6	nd
AB	5-16	5.5	nd	nd	0.59	.06	9.8	18.7	.8	2.8	66.5	11.2	13.6	nd
IIBmt1	16-29	5.1	nd	nd	0.87	.06	14.5	11.3	.0	3.0	73.1	12.6	30.1	nd
IIBmt2	29-44	5.2	nd	nd	0.77	.06	12.8	12.1	.1	2.8	72.4	12.6	26.1	nd
IIBC	44-58	5.4	nd	nd	nd	.06	nd	14.4	.8	2.3	69.3	13.2	19.3	nd
IIC	58-76	5.4	nd	nd	nd	nd	nd	10.3	.6	2.3	71.4	15.4	20.4	nd
IIIC	76+	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	3-0	nd	nd	nd	nd	nd	nd	nd	nd	263.5	93.5	86.3	7.2	4.3	nd	nd	nd
Ae	0-5	1	21	63	16	4	.95	64.9	68	30.6	22.9	5.9	17.0	.65	nd	nd	nd
AB	5-16	5	20	52	28	8	1.42	47.5	33	22.8	21.2	7.6	7.6	.69	nd	nd	nd
IIBmt1	16-29	1	1	40	59	22	1.32	51.2	39	40.1	28.8	16.8	12.0	1.4	nd	nd	nd
IIBmt2	29-44	4	4	42	54	24	1.24	54.1	44	42.4	28.2	16.3	11.9	1.4	nd	nd	nd
IIBC	44-58	5	18	38	44	18	nd	nd	nd	25.8	22.4	11.4	11.0	.92	nd	nd	nd
IIC	58-76	7	19	42	39	20	1.36	49.7	37	30.6	24.2	11.9	12.3	.91	nd	nd	nd
IIIC	76+	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd	nd

Sub-group: .... Orthic Gray Luvisol.

Profile number: .... D 9.

Location: .... Between Forestry Plots #586 and #585.

Vegetation: Tree Canopy: .... Pinus contorta, Picea sp..

Understory: .... Alnus sp..

Ground: .... Hylocomium sp..

Parent material: .... Colluvium/Till IIa/Shale/Residual/Rock.

Topography: .... Moderately sloping; aspect S..

Elevation: .... 5500 ft. M.S.L..

Drainage: .... Imperfect.

Horizon	Depth (cm)	Description
L - H	5 - 0	Organic material in various stages of decomposition.
Ae	0 - 5	Light brownish gray to pale brown (10 YR 6/2-6/3) silt loam, light gray (10 YR 7/1-7/2) when dry; strong, coarse platy; very friable; pH 4.5; moderately gravelly; clear, wavy boundary.
AB	5 - 12	Pale brown (10 YR 6/3) loam, light gray to very pale brown (10 YR 7/2-7/3) when dry; weak, coarse platy breaking to coarse, subangular blocky; friable; pH 4.8; moderately gravelly; clear, wavy boundary.
IIBt1	12 - 29	Yellowish brown to light yellowish brown (10 YR 5/4-6/4) silty clay loam, pale

Horizon	Depth (cm)	Description
IIBt1	12 - 29	brown to very pale brown (10 YR 6/3-7/3) when dry; strong, medium subangular blocky; firm; pH 4.4; clear, wavy boundary.
Bt2	29 - 39	Dark yellowish brown to yellowish brown (10 YR 4/4-5/4) clay, light yellowish brown (10 YR 6/4) when dry; strong, fine to medium subangular blocky; firm; pH 4.3; clear, smooth boundary.
IIIBC	39 - 48	Dark gray to grayish brown (10 YR 4/1-5/2) clay, gray to light brownish gray (10 YR 5/1-6/2) when dry; weak, medium subangular blocky; very firm; pH 5.0; gradual, smooth boundary.
IIIC	48 - 62	Dark gray (10 YR 4/1) clay, gray (10 YR 5/1) when dry; amorphous; very firm; pH 5.2; clear, smooth boundary.
IVC	62 - 64	Brown (10 YR 5/3) silt loam, pale brown to light yellowish brown (10 YR 6/3-6/4) when dry; amorphous; friable; pH 6.4; moderately channery; abrupt, smooth boundary.
VC	64 - 68	Dark brown (10 YR 3/3) loam, grayish brown to brown (10 YR 5/2-5/2) when dry; amorphous to single grained; very friable; pH 6.9; exceedingly channery, abrupt, bro-

Horizon	Depth (cm)	Description
		ken boundary.
Rock	68 +	Sandstone.

Sub-group: Gleyed Gray Luvisol Profile No.: D9.

Horizon	Depth	pH	Ca CO_3 equiv.	Ino. C	Org. C	N	C/N ratio	Exchange Analysis exch. acid.	Na	K	Ca	Mg	TEC	pH-depend. C.E.C.
	cm.		%	%	%	%		%	%	%	%	%	me/100 gms	%
L-H	5-0	3.9	nd	nd	nd	nd	nd	66.3	.2	6.3	27.2	.0	79.1	nd
Ae	0-5	4.5	nd	nd	1.0	.06	16	58.9	1.1	2.2	32.2	5.6	9.2	nd
AB	5-12	4.8	nd	nd	1.0	.08	13	40.0	.8	2.5	46.7	10.0	15.2	90.5
IIBt1	12-29	4.4	nd	nd	.5	.06	9	29.9	.0	2.3	59.2	8.6	21.8	97.7
IIBt2	29-39	4.3	nd	nd	.6	.05	12	21.8	.4	2.7	65.9	9.2	28.1	97.8
IIIBC	39-48	5.0	nd	nd	1.1	.05	nd	10.2	.4	2.2	76.7	10.5	31.1	97.2
IIIC	48-62	5.2	nd	nd	1.2	nd	nd	9.8	.3	1.7	73.4	14.8	31.0	99.8
IVC	62-64	6.4	nd	nd	.9	.07	nd	3.0	.4	1.7	88.7	6.2	30.6	99.8
VC	64-68	6.9	nd	nd	nd	nd	nd	2.7	.7	1.3	84.0	11.3	12.4	99.8

Horizon	Depth	Mechanical Analysis G	S	Si	C	FC	Bulk Dens.	Por.	Sat. Cap. (Theor.)	Moisture Analysis Sat. Cap.	1/3 bars	15 bars	Avail. Moist.	Hygr. Moist.	Free R_2O_3 (Oxalate) Fe	Al	Fe + Al
	cm.	%	%	%	%	%	gm/cc	%	vol.%	wt.%	wt.%	wt.%	wt.%	wt.%	%	%	%
L-H	5-0	nd	nd	nd	nd	nd	nd	nd	nd	253.7	93.3	78.7	14.6	3.8	nd	nd	nd
Ae	0-5	12	32	55	13	2	.91	66.3	73	27.8	19.7	5.4	14.3	.5	nd	nd	nd
AB	5-12	16	29	48	23	6	nd	nd	nd	26.6	19.7	7.7	12.0	.8	.05	.09	.14
IIBt1	12-29	4	12	41	47	17	1.32	51.2	39	29.6	24.0	12.5	11.5	1.1	.09	.10	.19
IIBt2	29-39	6	13	35	52	22	1.53	43.4	28	37.1	25.8	15.0	10.8	1.3	.14	.10	.24
IIIBC	39-48	0	2	30	68	25	nd	nd	nd	43.2	30.4	18.0	12.4	1.5	.06	.05	.11
IIIC	48-62	1	1	37	62	24	1.42	47.5	33	49.3	29.8	17.7	12.1	1.5	.08	.06	.14
IVC	62-64	2	12	68	20	6	nd	nd	nd	35.9	29.5	15.4	14.1	1.5	.09	.07	.16
VC	64-68	0	40	41	19	7	nd	nd	nd	25.6	15.6	6.3	9.3	.7	.09	.09	.18

Sub-group: .... Degraded Eutric Brunisol.

Profile number: .... D 10.

Location: .... Near Forestry Plot #388.

Vegetation: Tree canopy: .... _Pinus contorta_.

Understory: .... _Alnus_ sp., _Ribes_ sp., _Picea_ sp..

Ground: .... _Elymus_ sp., _Aster_ sp..

Parent material: .... Colluvium/Aeolian Colluvium/Till II B.

Topography: .... Moderately sloping; aspect SE..

Elevation: .... 5000 ft. M.S.L..

Drainage: .... Imperfect.

Horizon	Depth (cm)	Description
L - H	8 - 0	Organic material in various stages of decomposition.
Aeh	0 - 5	Black (10 YR 2/1) silt loam, very dark gray (10 YR 3/1) when dry; weak, medium granular; friable; pH 6.5; abrupt, smooth boundary.
Bm	5 - 12	Very dark to dark grayish brown (10 YR 3/2-4/2) silt loam, brown to yellowish brown (10 YR 5/3-5/4) when dry; strong, medium granular; friable; pH 6.7; abrupt, smooth boundary.
IIC	12 - 17	Dark yellowish brown (10 YR 4/4) silt, light yellowish brown (10 YR 6/4) when dry; platy; very friable; abrupt, smooth boundary.

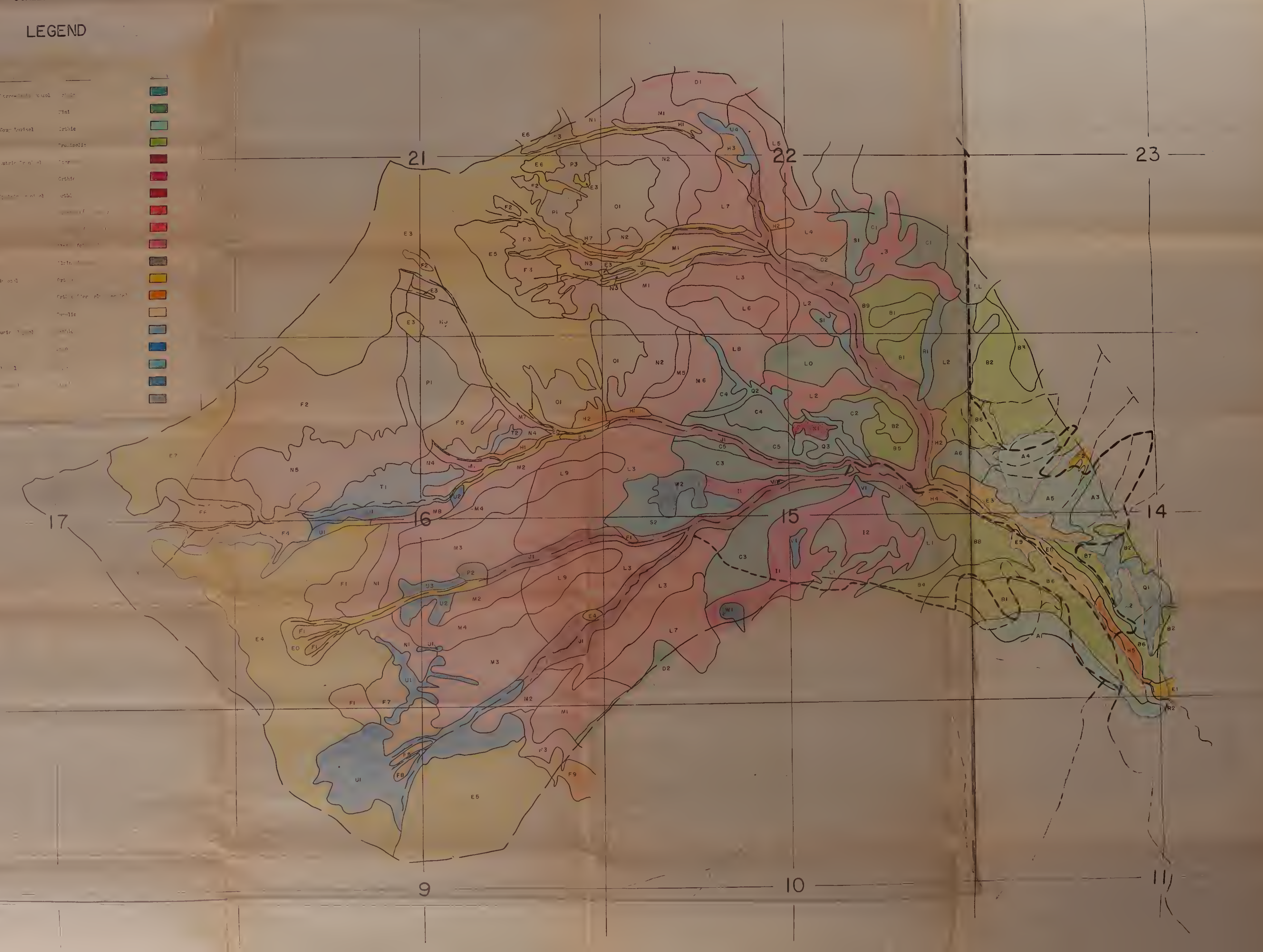
Horizon	Depth (cm)	Description
IIIC	17 - 50 +	Dark gray to dark grayish brown (10 YR 4/1-4/2) silty clay loam, grayish brown to brown (10 YR 5/2-5/3) when dry; amorphous; firm; pH 6.6; very channery to cobbly.

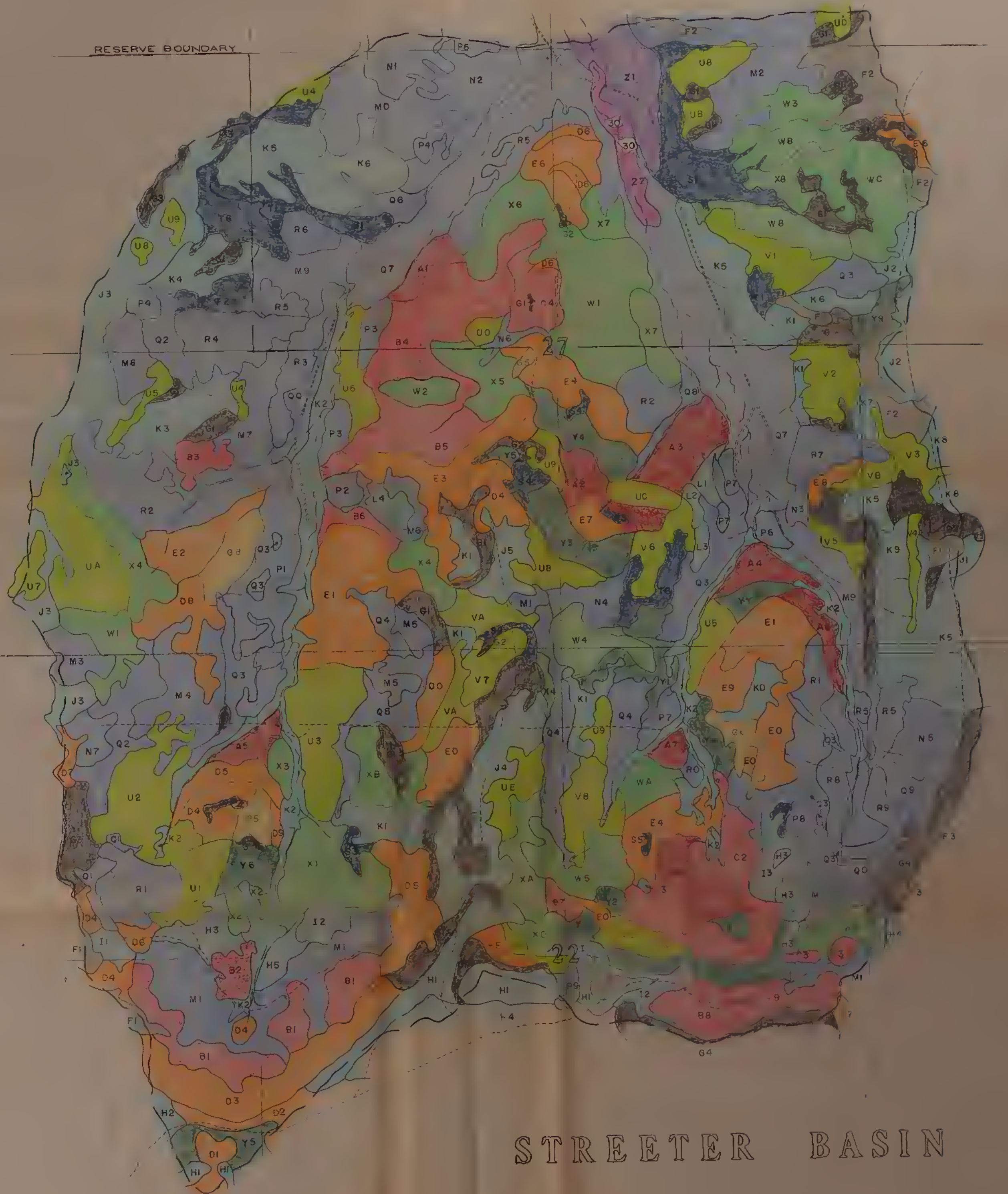
MARMOT CREEK BASIN

TWP. 23 RGE. 9 W5 MER.

SCALE: 1 IN. = 500 FT

LEGEND





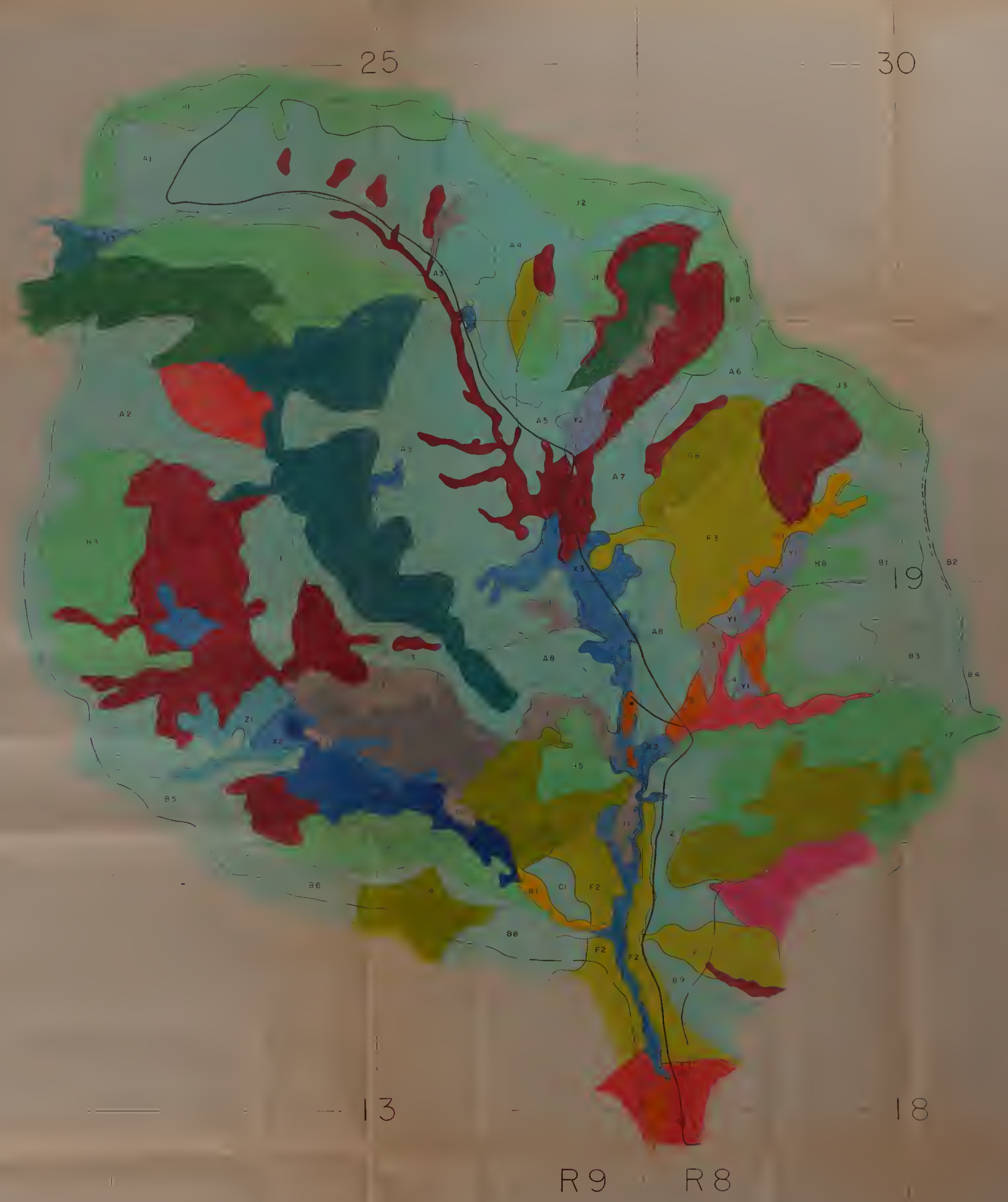
STREETER BASIN

TWP 13, RGE. 1, W 5 M

SCALE 1 IN = 500 FT

LEGEND

ORDER	GREAT GROUP	SUBGROUP	COLOUR
Chernozemic	Black	Orthic (montane)	
		Eluviated (montane)	
		Eroded	
		Orthic (thin)	
		Orthic (thick)	
		Orthic, Cumulic	
		Carbonated	
		Rego	
	Dark Gray	Orthic (thin)	
		Orthic (thick)	
		Orthic, Cumulic	
		Rego, Cumulic	
Gleysolic	Humic	Rego, Carbonated	
Organic	Humisol	Terric	
Regosolic	Regosol	Orthic	
		Orthic (formerly Georcic)	
Brunisolic	Eutric Brunisol	Degraded	
Luvisolic	Gray Luvisol	Orthic	
		Dark	



LEGEND

Luvisolic	Gray Luvisol	Orthic	920	
		Gleyed	910	
		Brunisolic	912	
		Gleyed Brunisolic	912	
		Bisequa	907	
		Dark	909	
[illegible]	Eutric Brunisol	Orthic	930	
		Gleyed	926	
		[illegible]	937	
		Gleyed [illegible]	937	
	Dystric Brunisol	[illegible]	922	
[illegible]	[illegible]sol	Ort[illegible]	916	
		[illegible]	918	
Chernozemic	Black	[illegible]	967	
	Dark Gray	[illegible]	967	
Gleysolic	Gleysol	[illegible]	906	
		[illegible]	905	
	Humic Gleysol	Orthic	906	
		Rego	933	
Organic	Fibrisol	Terric	906	

DEER CREEK BASIN

TOWNSHIP 31 WEST OF FIFTH MERIDIAN

SCALE 1 INCH = 500 FEET